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Pollution Abatement and Unemployment

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A report is presented of a study which develops a methodology to estimate the magnitude of unemployment that may be expected as a result of plant closures caused by pollution abatement requirements. This study is directed at the very small minority of plants that might reduce or cease operations and thereby lay off their employees. The report specifies the types of financial assistance required to avoid closure, and describes the kinds of plants affected and programs which might be instituted, should the need arise. The study also provided insights into the appropriate types of Federal Government response, should the magnitude of unemployment warrant action.

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POLLUTION ABATEMENT AND UNEMPLOYMENT

A Methodological Study

This report was prepared by
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Terry Trumbull and Helen Scott

January 31, 1972

Submitted to the
Office of Air Programs
and the
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of the
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January 31, 1972

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Gentlemen:

I am pleased to transmit the attached report, Pollution Abatement and Unemployment: A Methodological Study, by the Institute of Public Administration. The report was undertaken for the Office of Air Programs and the Office of Water Programs of the Environmental Protection Agency under Contract EHS-70-126. The study develops a methodology to estimate the magnitude of unemployment that may be expected as a result of plant closures caused by pollution abatement requirements. Three case studies are provided as practical illustrations of the methodology and a chapter on Federal programs completes the report.

Preparation of the report was the responsibility of John Hoicka, Principal Investigator, Terry Trumbull and Helen Scott. Research assistance was provided by Ralph Loewenstein and Arthur Wineburg.

We would like to express our appreciation to those staff members of the Office of Air Programs and Office of Water Programs who commented on the draft version of this volume in December 1971. Their suggestions have been incorporated in the appropriate sections.

Sincerely,

Sumner Myers

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Project Director

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SUMMARY

1. In recent years, the Federal Government has set air and water pollution standards which will require plants to invest in pollution abatement. In most industries virtually all plants will be able to pass on the costs of pollution abatement in the form of increased prices. Consequently, this study is directed at the very small minority of plants that might reduce or cease operations and thereby lay off their employees.

This report specifies the types of financial assistance required to avoid closure, provides a methodology to estimate the order of magnitude of unemployment, and describes the kinds of plants affected and programs which might be instituted, should the need arise.

2. Plants may reduce or cease operations in order to avoid the expense of pollution abatement for one of two mutually exclusive reasons and, on this basis, are here divided into two groups:

a) non-viable plants, i.e., those which cannot afford to pay for pollution abatement costs and would therefore require a subsidy if they are to continue in operation, and

b) potentially viable plants, i.e., those which could pay pollution abatement costs if they could secure a loan to cover the necessary initial outlay but are unable to borrow the necessary funds from a commercial lending institution.

It is significant that those plants which do abate will neither reduce nor cease operations prematurely as a result of abatement, and hence are not subjects for concern from a policy viewpoint.

3. Non-viable plants will generally be found among the smallest and/or the most obsolescent in each industry. The number will be reduced if the standards applied to these plants are less stringent than the standards applied to large plants.

4. Commercial lending institutions may refuse loans to some potentially viable plants because they underestimate the plant's ability to pass on the costs of pollution abatement in the form of increased prices.

5. A preliminary survey indicated that data needed to support a refined model were unavailable, and further, that data such as financial projections for individual plants would be very costly to obtain. A methodology was therefore developed which could use the available data. While the resultant model is crude, it can be used to estimate the order of magnitude of unemployment that may occur with the two categories of plant discussed above: the economically non-viable, and the potentially viable. Only published data need be used throughout with the exception of estimates for pollution abatement costs for small or obsolescent plants. The latter can be easily developed by EPA if it wishes to use the model. Three case studies, for illustrative purposes only, apply the methodology to three different types of industry: labor, capital, and resource intensive.

6. As the case studies illustrate, the methodology may provide estimates of plant closures and unemployment that are relatively precise for some industries while being less so for others. These discrepancies can be expected to offset one another in summing the estimates for all industries. From a policy point of view, the important question is whether the sum of all the estimates provides a measure of unemployment at the national level that is sufficiently reliable to form the basis for a decision.

7. The methodology identifies certain industries where pollution abatement is most likely to result in unemployment. If these industries are considered critical in some sense, EPA may wish to conduct more intensive studies of the impact of abatement requirements on the small and/or obsolescent plants in the industries so identified.

8. Again, this is a methodological study, and quantitative results are for illustrative purposes only. In the course of the analysis, however, three findings of particular significance emerged.

a) Many plants which close rather than abate would have closed in any event within a period of a few years.

b) Because a large proportion of these plants are small or obsolescent and are located in economically stagnant or declining areas, a disproportionate share of closures will be in areas of chronically high unemployment. Pollution abatement will compound the problems already responsible for the declining fortunes of these plants. The extent of the ensuing unemployment will depend on such factors as the nature and severity of the legislation imposed, the location of the plants, and the age distribution and skills of the employees.

c) The number of potentially viable plants--that is, plants needing loans--is likely to be very small.

9. The study also provided insights into the appropriate types of Federal Government response, should the magnitude of unemployment warrant action.

a) There is no point in considering loans for non-viable plants, because the plants will be unable to repay the loans. For non-viable plants, the options are as follows:

i) No assistance. This decision would force plants to close and employees to seek unemployment benefits through Social Security and other programs. In such instances, retraining and relocation assistance might be provided to displaced workers. In either case, the costs will ultimately be borne by consumers and the displaced workers.

ii) Subsidies. Abatement costs could be directly subsidized wholly or in part. In most instances a combination of subsidy and loan assistance would be sufficient, the amount of the loan being dependent upon the plant's ability to repay it.

iii) Variances. Variances are a form of indirect subsidy. If a variance is granted, damages caused by pollution will still persist, but in areas where there are few polluters the effects may be small and ambient air or water quality standards may not be violated.

b) While small plants, having less to offer as security, do experience greater difficulty than large plants in borrowing money from commercial sources, there is no evidence to suggest that they are victims of unfair discrimination. The Small Business Administration is designed to assist firms that are unable to comply with established lending practices, and whose loan applications have been rejected by banks. There appears to be no reason why the SBA should not resolve problems concerned with loans to cover air pollution costs.

c) A generally successful company may own one or more plants that are economically non-viable and each of these plants may thus qualify for a subsidy. It should be noted, however, that no subsidiary of a successful parent company could be regarded as "potentially viable" since it must be assumed that a loan could be arranged through the parent.

CHAPTER 1

METHODOLOGY (PART I): AN OUTLINE

> In order to know anything it is necessary to know everything, but in order to talk about anything it is necessary to neglect a great deal.[1]

In order to estimate the potential number of non-viable plants in U.S. industry and the associated magnitude of unemployment, three points to be noted are:

1. Plants (or operations within plants) will close down rather than abate if the investment cost of pollution abatement (i.e., exclusive of operating and maintenance costs) exceeds the anticipated net present value of the plant;

2. Future unemployment is not a policy issue because once abatement is carried out, the life expectancy of the remaining plants will, in most cases, increase. Similarly, after an initial delay, employment in the remaining plants will probably increase slightly.

3. Plant ownership is not an issue since economically non-viable plants will close whether or not they are part of a prosperous multi-plant concern, and the resulting unemployment will be the same.[2]

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1. Joan Robinson, "Rising Supply Price," Economica N.S., Vol. VIII (1941), p. 8.

2. These points are discussed in mathematical terms in Appendix A, Economics of the Individual Plant.

Summary of Estimation Procedures for Non-Viable Plants

Of the hundreds of thousands of plants operating in the United States, only a few will close down (or abandon operations) rather than comply with pollution abatement requirements. Even if the data were available, it would be extremely costly to cull the closures from the rest through a plant by plant analysis. In point of fact, financial projections are closely guarded secrets and it is difficult to acquire pollution abatement cost data that is more refined than the industry level.

While there are some differences in the procedures followed by single-plant and multi-plant concerns, they are not easily identified or quantified owing to the secrecy surrounding financial data. Generally speaking, multi-plant concerns have more options, in that they can rearrange production among different plants, move equipment, transfer skilled labor, and so forth. But since the question addressed in this report concerns unemployment, no attempt is made to differentiate unemployment caused by multi-plant concerns from that caused by single plant entities.

The estimation procedure suggested here seeks to provide a cost-effective estimate of the nationwide impact of closures on unemployment. Based on readily available data, it provides only a crude approximation to the actual number of closures in each industry.[1] Accuracy for a specific industry, however, is important only insofar as it affects the aggregate figures of closures and unemployment.

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[1] In the summer of 1970, President Nixon invited Dr. Paul McCracken to head an inter-agency Task Force to study the economic impact of pollution control and to recommend, if necessary, measures to ease the burden. A range of costs for the control of pollution under existing standards has been prepared for eleven industries considered to be major polluters and the impact on employment and profitability is now being studied by private consulting firms. The industries are: automobiles, bakeries, cement plants, iron foundries, canned and frozen fruits and vegetables, primary non-ferrous metals, pulp and paper, petroleum refining, leather, steel and electric utilities.

By summing low and high estimates of closures in each industry, a range is obtained for the economy as a whole. A disproportionate share of the unemployment, as estimated, will be long-term in nature, because a disproportionate share of plant closures will be in the regions of chronic unemployment. Only if the range, as revised to consider long-term unemployment, is not sufficiently accurate to determine an appropriate federal response, need refinements be made. In this latter case, detailed studies might be carried out for those particular industries whose estimates significantly affect the total dispersion in the estimates of national unemployment.

Low Pollution Abatement Costs

For many industries, the initial outlay, [i.e., the investment cost of pollution abatement (PA)], is so small that a negligible number of plants would be forced to close purely as a result of the financial burden involved. For estimation purposes, then, the first step is to exclude from consideration industries for which this cost is very low.

The overall cost of pollution abatement to the plant is based on the costs incurred by the firm or plant itself and changes in the cost of materials purchased which have resulted from pollution abatement in the supplying industries. Unfortunately, analyzing this stream of costs might involve a complex, possibly computerized, model which might well be beyond the scope of the effort suggested here. One fairly reasonable substitute would be to compare the cost of pollution abatement within a given industry to value added. Alternatively, the cost could be compared to value of shipments, although in most cases this would understate the price increases required to break even.

The appropriate definition of PA should include the capital cost of pollution abatement in excess of an established norm for the industry. Recently, more stringent legislation has been enacted for several types of abatement. The incremental cost to each plant is, of course, the sum of incremental costs of each type of abatement.

Information available during the course of this study related only to the incremental costs of air pollution, though EPA is now in the process of estimating similar data for other kinds of pollution abatement. For lack of this other data the figures for air pollution were used in the case studies, then, on the understanding that quantitative results were for illustrative purposes only.

In Table 1-1, EPA estimates of the investment costs of air pollution (column 3) are compared with annual value of shipments for the industry as a whole (column 1).[1] The ratio exceeds 1 percent in only ten cases, and 5 percent in only one case. It appears, therefore, that plant closures due to pollution abatement will be limited to a very few industries.

Price Increases

Since an entire industry must abate, the added cost is

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[1] In most cases the industries defined are not equivalent to a specific 4-digit Standard Industrial Code (SIC), and therefore we have been unable to compare the investment costs of pollution abatement with value added.

Table 1-1

ANNUALIZED INVESTMENT COST OF AIR POLLUTION ABATEMENT AS A PERCENTAGE OF VALUE OF SHIPMENTS[1]

(Fiscal Year 1976; 298 Metropolitan Areas)

	Value of Shipments ($ billions)	Investment ($ millions)	Annualized Investment[2] ($ millions)	Annualized Investment Cost as a Percent of Value of Shipments
Asphalt Batching	1.6	15.4	3.1	0.2
Brick and Tile	0.2	40.8	8.2	4.1
Coal Cleaning	0.8	13.1	2.6	0.3
Cement	0.9	110.0	22.0	2.5
Elemental Phosphorus	0.1	6.6	1.3	1.3
Grain: Handling	N/A[3]	436.0	87.2	N/A[3]
Milling	4.8	27.4	5.5	0.1
Gray Iron Foundries	3.5	317.3	63.5	1.8
Iron and Steel	17.4	981.0	196.2	1.1
Kraft (sulfate) Pulp	3.7	73.0	14.6	0.4
Lime	0.3	10.6	2.1	0.7
Phosphate Fertilizer	1.8	32.1	6.4	0.4
Primary Nonferrous Metallurgy: Aluminum	1.1	223.3	44.7	4.1
Copper	0.8	87.0	17.4	2.2
Lead	0.1	16.2	3.2	3.2
Zinc	0.3	4.7	.9	3.0
Rubber (Tires)	4.6	1.9	.4	0.9
Secondary Nonferrous Metallurgy	1.8	61.9	12.4	0.7
Sulfuric Acid	0.3	176.0	35.2	11.8
Varnish	0.1	.8	.2	0.5

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1. Estimated costs for controlling particulate, sulfur oxide, carbon monoxide, hydrocarbon, fluoride and lead emissions from facilities expected to be operating in fiscal year 1976. Credit for increased sulfuric acid is not included. The metropolitan areas are defined, Economics of Clean Air, Appendix 1.
2. Capital related share of annual costs or approximately 1/5 of the investment cost.
3. Not applicable

Source: Adapted from the Economics of Clean Air, Report of the Administrator of EPA to the U. S. Congress (Washington: GPO, 1971) pp. 4-19, 4-20.

similar in nature to other costs imposed by regulation. Just as an excise tax, for example, is promptly passed on in the form of increased prices,[1] so will pollution abatement costs be passed on in many instances. It will be difficult to raise prices if the product has close substitutes, or if the industry has substantial international (or interregional) competitors with much lower abatement costs. But apart from these situations, the procedure for estimating price increases may be summarized as follows:

(1) For many industries in the United States, ownership or control is concentrated in the hands of a relatively small number of firms. In these cases, it is relatively easy to increase prices to cover the pollution abatement costs of most, if not all of the plants in the industry.

(2) In industries with diffused ownership, price changes are dictated by the elasticities of demand and supply. The following generalizations may be made:

(a) If demand is price inelastic, most plants will be able to cover their costs of pollution abatement, at least approximately, by raising their prices as the costs are incurred.

(b) If demand is price elastic, on the other hand, the response may vary according to the type of industry. The more labor intensive the industry, the more quickly

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[1] If the industry is resource intensive, some of the costs may be shifted back onto the resource owners. In any event, the process itself is either capital or labor intensive, and the general conclusions hold.

> will prices be increased, even if production must be reduced as a result. If the industry is capital intensive and excess capacity exists, the price increase may be delayed until demand has grown to meet supply. At that time, the price will increase rapidly to the point at which most plants recover their costs.

It follows, therefore, that prices increase rapidly except when a concentrated capital intensive industry faces elastic demand and excess capacity at the same time.

Plant Closures

There are two principal reasons why plants close instead of abating. If there are indications that a plant is liable to close within a few years in any event, the necessity of making an initial outlay for pollution abatement might decide management that it would be wiser to cease operations immediately. Such plants may be termed "short-run." Or, alternatively, plants might have costs of abatement so much above the industry average (i.e., differential costs) that the unrecovered costs would exceed the discounted cash flow for the plant. These two issues are examined in the sections below.

Short-Run Plants. The investment cost of pollution abatement is assumed to be borne over a period of ten or more years at an interest rate of 14 percent. Plants that will probably not survive so long must amortize the cost over a shorter period of time. In other words, the net present value of the plant might be so small that it is exceeded by the investment cost of pollution abatement, and the plant will then cease operations.

An average lifespan required to justify continued operations can be estimated, albeit in a crude manner. On one side of the ledger is the investment cost of pollution abatement. On the other side is the sum, for a given number of years, of the estimated net present value. To estimate the latter figure accurately would require financial projections for individual plants, and these, as has been noted, can only be obtained at great expense. The procedure used here is to utilize industry average figures for small plants in labor intensive industries, and to modify these figures by an estimate of relative payroll costs for obsolescent plants in capital intensive industries. The number of plants which would close within the compared time period is estimated by projecting the failure rate of the industry. This figure has been multiplied by an estimate of plant employment to arrive at potential unemployment.

Differential Pollution Abatement Costs. Costs of Pollution abatement, particularily initial capital expenditure, frequently vary as a proportion of sales for differential plants in a given industry, even if similar equipment is required of all. The two major determinants of such differences are plant size and plant age.

So far as size is concerned, economies of scale for pollution abatement equipment essentially favor the larger plants. This advantage is more significant for labor intensive than capital intensive industries, since there is considerable size variation in the former as against a tendency to uniformity of size in the latter. Investment in pollution abatement equipment will change the relative labor/capital intensity of an industry; a probable response, from labor intensive industries in particular, will be mergers between smaller plants or their absorption by larger competitors.

Differences in plant age create an abatement cost differential which generally operates in favor of newer plants. Installation of equipment in older plants is often hampered by the fact that their original design may not have taken pollution abatement requirements into account. Existing systems, for similar reasons, may need extensive and expensive alteration. In addition, plants employing obsolescent processes may have difficulty in absorbing high pollution costs, since there is so little return for them over and above payroll and the cost of supplies.

Factors affecting the methodology applied to non-viable plants, as outlined above, will be developed in more detail in the two following chapters.

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1. The considerable variation in legislative requirements for pollution control is another important factor in cost differentiation. See Appendix B.

CHAPTER 2

METHODOLOGY (PART II): PRICE INCREASES

The general conclusion of this chapter is that in the large majority of industries virtually all plants will be able to increase their prices by an amount that is adequate to cover the costs of pollution abatement. Notable exceptions to this generalization are discussed below (see p. 2-11).

Industries with Concentrated Control

It is quite common for U.S. industries to be dominated by a few large companies. One highly regarded study notes, for example, that in 1954 four (or fewer) firms controlled the following percentages of value of shipments: primary aluminum (100 percent), passenger automobiles (98 percent) electric lamps (93 percent), and so on.[1]

In such industries, one can hardly say that "impersonal market forces" determine the level of prices. Rather, prices are decided according to accepted conventions, varying by industry. In some cases, there is strong price leadership, and a single firm dictates a set of prices maximizing its own return, subject only to extreme discontent by weaker firms. In other cases, when one firm does predominate, different firms may tentatively raise or lower prices to test the reaction of the industry. Frequently the result is an intricate bidding process, in which other firms respond with different changes, and gradually a new price level is established.

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[1] Joe S. Bain, International Differences in Industrial Structure (New Haven: Yale University Press, 1966), p. 78.

In this type of situation, if a new cost such as pollution abatement is imposed, it provides a ready initial signal about the probable size of the next price increase. The precise amount of the increase will depend upon the exact nature of the bidding process, the number of other issues involved (such as wage increases) and the recent history of price increases in the industry.

Not infrequently, costs such as pollution abatement or wage increases provide an excuse to raise prices to a level that includes a profit increase as well. Such pretexts are considered necessary because U.S. industry is usually reluctant to maximize short-run profits if it might hinder long-run existence and growth. Noticeably high profits might lead to investigations by the anti-trust division, consumer advocates, or political interests. In addition, a rapid increase in profits generates a demand by labor for increased wages. It follows then, that price increases in industries with concentrated ownership will adequately cover the costs of most, if not all, plants in the industry; indeed many will probably increase profits as well.

Regulated Industries

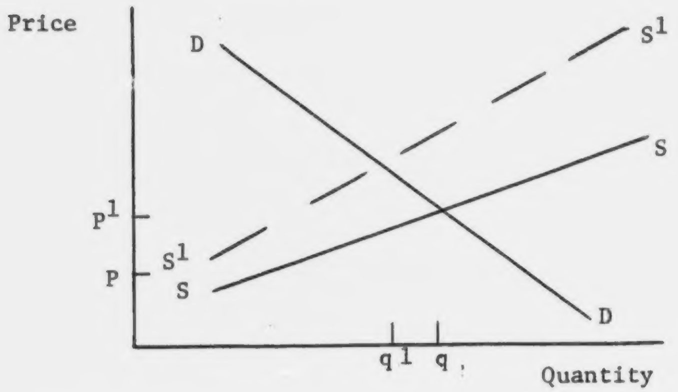
One of the primary purposes for regulating an industry is to control monopolistic tendencies. Within the established framework of controls, it is a comparatively simple matter for the regulatory agencies to permit price increases to cover the costs of pollution abatement.

Impersonal Markets

Price changes in an impersonal market can be estimated by making use of economic analysis of supply and demand. In classical economic theory, the price of a product depends on supply and demand, assuming that both producers and buyers have complete freedom of choice, as well as the ability, to produce and buy according to their own best interests. When the supply and demand curves intersect, a market equilibrium of quantity and price is created. While shift in supply and demand may upset the equilibrium in the short-term, the same shifts will, in the long run, result in a new equilibrium.

In the present analysis, pollution abatement results in a shift of the supply curve: supply diminishes at each potential price. Figure 1 illustrates the situation. Curve DD represents demand for the product; it slopes downward to reflect the fact that the quantity demanded increases as price decreases. The initial supply curve, SS, on the other hand, slopes upward, since the quantity supplied and price are positively related. In both instances, the sharper the slope, the less sensitive is demand or supply to the price changes.

FIGURE 1



A second supply curve, S'S', is drawn above the first, indicating the effect of the increased costs of pollution abatement. Figure 1 shows that the price of the product will increase from p to p', and the quantity decreases from q to q'. It is evident that the magnitude of each of these changes depends upon the magnitude of pollution abatement costs and the slopes (or inelasticities) of the two curves.

A number of points should be made. First, if the new equilibrium reduces trade, a number of plants within the industry will reduce or cease operations before this equilibrium is reached.[1] Second, the supply curve may not be shifted to its full extent immediately. The course it follows depends upon characteristics of the industry. Third, during the time taken for adjustment, increasing national or regional income may cause the demand to increase at each potential price, thus shifting the demand curve outward. This increase in demand may suffice to lessen, or even eliminate, the reduction in quantity.

Price Inelastic Demand

If demand is price inelastic, prices will increase rapidly to cover the costs of pollution abatement for most, if not all, plants in the industry. Unfortunately, estimation of price elasticity is extremely difficult and requires sophisticated statistical methods. Reasonably accurate results are available for a few commodities only.[2]

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[1] Establishments will not reduce operations proportionately if pollution costs are not the same in relation to value of shipments. (See Chapter 3.)

[2] See Herman Wold and Lars Jureen, Demand Analysis (New York: John Wiley and Sons, 1953).

The approach selected here is to utilize a few simple guidelines that can be used to indicate roughly the price elasticity of demand. The following conclusions are discussed in many microeconomic textbooks.[1]

1. If close substitutes are available, (and their price increases are smaller), demand is likely to be somewhat price elastic.

2. If the product is usually bought for use in combination with other goods (e.g., gasoline), demand is likely to be somewhat price inelastic.[2]

3. If the price of the product is a small proportion of the consumer's budget (e.g., table salt), demand is, again, likely to be somewhat price inelastic.

Acting on these broad assumptions, it can nevertheless be a complex matter to decide whether a particular product is price elastic or inelastic. Usually a number of considerations peculiar to that product have to be weighed judiciously before arriving at a definite conclusion.

Price Elastic Demand

If demand is price elastic, on the other hand, it is difficult to increase prices without repercussions in the industry. Whether the price increase is delayed, or production is reduced depends on the price elasticity of supply for the industry.

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[1] See John R. Hicks, Value and Capital (2d ed.: Oxford: Clarendon Press, 1948), p. 32-36; and James M. Henderson and Richard E. Quandt, Microeconomic Theory (New York: McGraw Hill, 1958), p. 26. Other elements influencing demand include quality, service, etc.

[2] See Close Substitutes and Differing Pollution Abatement Regulations, below.

The supply curve for the product depends upon the supply curves for the various factors of production: labor, capital, and resources or supplies. An industry may have constant costs because its derived demand for factors is so small in relation to quantities traded in the factor market that changes in the industry's demand do not affect factor prices. This situation occurs when factors are sufficiently mobile to shift from the industry in question to other industries (at least in the long run). In this case long-run supply of the product is extremely price elastic, and the price will be increased by the full amount of the pollution abatement cost. The number of plants and the output of each will then depend on the exact price elasticity of demand and the rate at which demand increases over time.

An industry may be subject to increasing costs if it purchases a significant proportion of specialized factors that have few alternative uses. To the extent that this is so, the price increase will not reflect pollution abatement costs to the full because part will be borne by the suppliers of the specialized factors through a reduction of their prices. The division of burden between resource owners and consumers again depends upon the price elasticity of demand, as well as the rate at which demand increases over time.

Even when supply contracts have been made on a long-term basis, it may be possible to renegotiate the price if this is necessary to save the producer from bankruptcy. This is most likely to happen if the market for raw materials is controlled by a few firms.

If demand is price elastic, it follows that price elasticity of supply is important in determining the rate and magnitude of price changes associated with air pollution control. It may therefore be helpful to discuss this point in relation to the three types of industry under consideration in this study.

Labor Intensive Industries. A labor intensive industry[1] is defined as an industry that uses a relatively large proportion of labor in relation to capital. Table 2-1 indicates in a rough manner the relative labor intensity of various two digit Standard Industrial Code (SIC) industries surveyed in the Census of Manufacturing in 1967. Taking 47.1 as the average percentage for all manufacturing, it follows that as an industry payroll exceeds this percentage of value added it is more readily defined as labor intensive.

Labor -- especially unskilled labor -- is relatively mobile. It is no particular advantage for an unskilled worker to remain with the same firm, so that if there is any question of a pay-cut he will probably change his job rather than accept lower wages.[2] A skilled worker has a stronger motive to remain with the same firm. His training has meant an investment in time (both for himself and his

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[1] "Case Study #1: Gray Iron Foundries" (Chapter 5) has been prepared as an example of the effect of pollution abatement costs on a labor intensive industry, albeit of one with price inelastic demand.

[2] One source points out that most employees will have very little information about their alternative prospects and hence will feel that they should search for a new, and possibly better-paying job before accepting the reduction in pay. As the search continues unsuccessfully, expectations tend to be revised downward. Axel Leijonhufvud, On Keynesian Economics and the Economics of Keynes (New York: Oxford University Press, 1968), p. 77 ff.

Table 2-1

PAYROLL AS PERCENTAGE OF VALUE ADDED IN TWENTY INDUSTRY GROUPS - 1967

Industry	Payroll as percent of Value Added[1]	Rank
Total Manufacturing	47.1%	
Lumber & wood products	56.2%	1
Leather & leather products	55.5%	2
Apparel & other textile products	55.4%	3
Furniture & fixtures	54.1%	4
Transportation equipment	53.8%	5
Textile mill products	53.8%	6
Electrical equipment & supplies	52.9%	7
Fabricated metal products	51.6%	8
Machinery, except electrical	51.1%	9
Printing & publishing	49.8%	10
Miscellaneous manufacturing industry	49.8%	11
Primary metals industry	49.3%	12
Rubber & plastics, n.e.c.	48.3%	13
Stone, clay & glass products	45.9%	14
Paper & allied products	45.4%	15
Instruments & related products	43.9%	16
Food & kindred products	37.8%	17
Chemicals & allied products	27.4%	18
Petroleum & coal products	22.4%	19
Tobacco manufacturers	18.4%	20

Source: U.S. Department of Commerce, Bureau of the Census, *1967 U.S. Census of Manufacturing: Industry Statistics*, Vol. II (Washington, D.C.: Government Printing Office, 1970).

employer) and money, in that he has accepted lower initial wages during this period.[1] Alternative jobs are fewer in number for him than for the unskilled worker and he is therefore more likely to accept a temporary pay cut.[2] His interest in remaining in his job decreases in direct ratio to the expected duration of the pay cut. Companies are often unwilling to risk losing skilled employees by imposing temporary pay cuts.

It follows, therefore, that as the industry becomes more labor intensive the distinction between the short-run and long-run supply curve becomes less clearly defined. Thus prices will increase rapidly, even if this means a reduction in output associated with price elastic demand.

Even so, the reduction in output will be small if substitute products also increase in price owing to the costs of pollution abatement. Another possibility is that the industry can utilize suppliers as "insurance" against short-run fluctuations in demand and profitability.[1]

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[1] Gary S. Becker, Human Capital (New York: National Bureau of Economic Research, 1964).

[2] This setting helps to explain why management is often able to perform sudden cost-cutting exercises in a recession. Business Week, for example, noted:

> When top management realized last summer [1970] it was contending with a recession, the knee-jerk reaction was to launch far-reaching cost-cutting campaigns. Unemployment rolls swelled, and in some cases employees took pay cuts ...

This article continued, however, that as business conditions improved, wages were restored for those who had taken cuts, and management was starting to refill positions left vacant by economy moves. Many of the moves were essentially short-run cuts designed to force workers who depended on the company's success to share part of the costs of uncertainty. "Trimmed Paychecks Put Back Lost Weight," Business Week (July 17, 1971), p. 35.

Capital Intensive Industries. An approximate indication of capital intensity is given by a firm's ranking as indicated in Table 2-1. Firms with a low payroll as a proportion of value added are capital intensive.[2] The distinguishing feature of a capital intensive industry is that large sums of capital are committed to an establishment, and then have relatively little use in alternative situations. This immobility is likely to be reflected in a reluctance to invest capital until a return seems assured, but once the investment is made, management finds that it is usually best to operate either close to full capacity or not at all. Supply is therefore price inelastic in the short-run but price elastic in the long-run.

If demand is price elastic, increased costs caused by new pollution abatement requirements may not be passed immediately if demand is weak or excess capacity exists. Prices will rise gradually as demand for the product increases because construction of new capacity will be delayed until profits return to normal (i.e., long-run supply is inelastic).

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[1] The automobile industry provides an appropriate example. When the industry anticipates suddenly reduced profits, for example, during the recent (1971) wage price freeze, buyers for the various companies attempt to renegotiate with suppliers to obtain lower prices. These tactics could not succeed if suppliers did not regard their overall arrangements with the companies as satisfactory.

[2] "Case Study #2: Portland Cement Industry,"(Chapter 5) has been prepared as a simple example of the effect of pollution abatement costs on a relatively capital intensive industry, albeit of one with price inelastic demand.

Resource Intensive Industries. The distinguishing feature of a resource intensive industry[1] is that it depends to a great extent on raw materials. As Table 2-2 indicates, cost of materials averages just over half the value of industrial shipments. Often industries processing raw materials, such as copper or petroleum, have a cost of materials much greater than the industry average. When this happens, the shape of the supply curve becomes important because it affects analysis of the response to pollution abatement costs.

If demand is price elastic, it may be difficult to increase prices rapidly. Since the process itself is either capital or labor intensive, the industry reaction can be determined by reference to the sections above.

If reductions in output do occur, the industry's derived demand for raw materials may fall perceptibly. As a consequence, prices for the raw material will weaken, both in the short- and long-run, with the result that consumers and resource owners will share the burden of pollution abatement costs.

As a secondary consequence, there will be a diminution in the size of the resource intensive industry caused by reduction in demand, and possibly a loss of markets to foreign competition.

Close Substitutes

Some products have close substitutes and therefore price increases are made with difficulty. In the production of soap, for

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[1] "Case Study #3: Primary Copper Smelters" (Chapter 5) has been prepared as a simple example of the effect of pollution abatement costs on a resource intensive industry.

Table 2-2

MATERIALS AS A PERCENTAGE OF VALUE OF SHIPMENTS
TWENTY-ONE INDUSTRY GROUPS-1967

Industry	Materials as percent of value of shipments	Rank
All Industry	53.6%	
Petroleum and Coal Products	76.0%	1
Food and Kindred Products	68.5%	2
Textile Mill Products	59.3%	3
Transportation Equipment	59.0%	4
Tobacco Manufactures	58.6%	5
Primary Metal Industry	58.3%	6
Lumber and Wood Products	55.6%	7
Paper and Allied Products	53.8%	8
Apparel and Other Textile Products	53.1%	9
Leather and Leather Products	49.2%	10
Fabricated Metal Products	48.3%	11
Rubber and Plastic Products	46.8%	12
Furniture and Fixtures	46.7%	13
Miscellaneous Manufacturing Industries	45.4%	14
Electrical Equipment and Supplies	44.8%	15
Chemicals and Allied Products	44.6%	16
Machinery except Electrical	43.8%	17
Stone, Clay and Glass Products	42.5%	18
Ordnance and Accessories	40.6%	19
Instruments and Related Products	36.3%	20
Printing and Publishing	34.6%	21

Source: U.S. Department of Commerce, Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol.II (Washington, D.C.: Government Printing Office, 1970).

example, many different kinds of oils can be used. If the price of one is increased noticeably, it may simply be replaced by another. Since the processes used to make palm oil, soy bean oil, and other kinds of oil differ markedly, it is quite possible that the costs of abatement will also differ markedly, and an industry may have to absorb a substantial portion of the costs or lose much of its market. It appears, however, from the list of industries considered by the CEQ to be major polluters that this is not a very important issue.

Differing Pollution Abatement Regulations[1]

In most instances, the effect of differing interregional or international pollution abatement regulations will be to keep the industry price increases to a minimum. While it is true that foreign industry, assuming it has lower pollution abatement costs, will expand and take over some of the U.S. demand, this is more a long-run than a short-run problem. In any case, if the effects of foreign competition become appreciable, new technology will be devised to reduce the costs of pollution abatement. To the extent that this technology is successful, American industry will be able to regain part of the market lost to foreign firms. In fact, it is easy for several reasons to overstate the effects of abatement costs in terms of international trade.

All major U.S. trading partners are becoming aware of the importance of pollution control and any price advantages their goods may have in this respect will be temporary.[1] In Canada and Scandinavia, for example, strict pollution control laws have already been enacted. Furthermore, many of the new requirements for pollution abatement within the United States require the use of specialized capital equipment for goods that are only sold in the domestic market. Thus, foreign producers are faced for these goods with a non-trade barrier because their own domestic markets for these goods are so small that it is uneconomic for them to compete in the American market.[2]

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[1] See Also Appendix B.

Finally, most American goods differ to some extent from the goods of other countries, either in terms of product differentiation or transportation costs, and this fact tends to limit the encroachment of foreign producers.

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[1] Since the trade advantages will come only to those industries with extraordinary pollution problems, Americans will, in effect, be exporting pollution to other countries. If a rapid buildup of heavily polluting industry occurs abroad, public pressure will mount very quickly to have the pollution controlled, even though foreign populations are at present unconcerned. It is frequently the case that major changes contain in themselves the seeds of reversal of that change.

[2] The requirements for low pollution automobiles in 1975 is a well known example which appears to be very disadvantegeous to foreign car manufacturers.

CHAPTER 3

METHODOLOGY (PART III): PLANT CLOSURES

There are two principal reasons why non-viable plants close instead of abating. First, if there are indications that a plant is liable to close within a few years in any event, the necessity of making an initial outlay for pollution abatement might decide management that it would be wiser to cease operations immediately. Second, plants might have costs of abatement so much above the industry average that the unrecovered costs would exceed the discounted cash flow for the plant. These two issues are examined in the section below.

Short-Run Plants

Plants which must bear the costs of pollution abatement over a very short period of time are particularly likely to cease operations. The different characteristics relating to each type of industry in this connection are discussed below.

Capital Intensive Industries

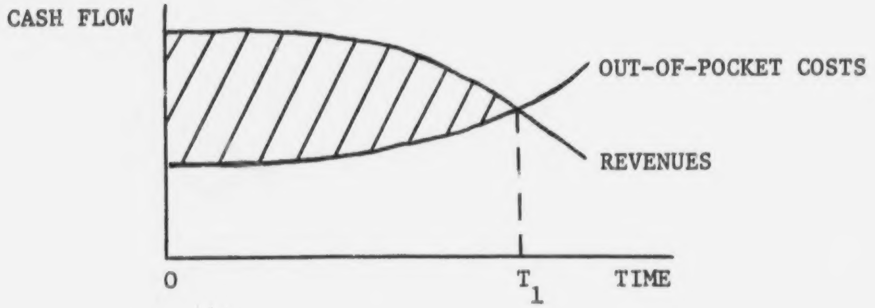
As a plant become obsolescent, it will tend to lower prices rather than lay off workers. Thus, instead of decreasing production over the years, the plant will exhibit declining return to invested capital. Finally, of course, it will produce only during peak periods of demand. Another manifestation of the same result -- lack of competitiveness -- is apparent if the firm has high variable costs relative to the industry average, i.e., labor and supplies, compared to value added.

This lack of competitiveness is reinforced by the nature of decisions made in a capital intensive industry. So long as a new cost is minimal, it does not precipitate consideration of the plant's ceasing operations. But, more importantly, capital expenditures are viable only if the plant is likely to operate for a considerable number of years with a good profit. Therefore, when doubt exists in the minds of managers as to the viability of the plant, major expenditures are often delayed in favor of increased maintenance. As more decisions are made in favor of variable cost solutions, the variable cost of the plant tends to climb. This reluctance to purchase new equipment soon reaches a point of no return, and the overall level of variable costs becomes far greater than the industry average.

Particularly in the case of price elastic demand, obsolescent establishments may have difficulty in absorbing the short run costs. In some cases, this cost will be so high that the establishment will cease operating, possibly blaming pollution regulations.

The principal reason why these plants close, however, is that they are no longer competitive and would have closed in the near future in any case. Often, the defining characteristic of this type of plant is that the cost of supplies and wages of production workers combined are a far higher proportion of the cost of production than the industry average. Another reason is that the value of capital invested in the plant has already sunk to a minimum thus reflecting all of the factors, including technological obsolescense, which indicate the plant is in its last years. Usually, there will be other telltale signs. In the plant itself, capital equipment has been allowed to run down over a number of years and employment, other than for maintenance, has decreased. The industry has probably experienced a series of closures among old plants over a period of several years. In other words, pollution abatement requirements can be considered only as the straw that broke the camel's back; and straw, even a minor technological advance in the industry, might be sufficient to close these plants.

FIGURE 1



As Figure 1 illustrates, revenues exceed out-of-pocket costs until time t_1; the time at which the plant would close in the absence of pollution abatement requirements. The shaded area, when discounted appropriately, represents the net present value of the plant.[1]

Once abatement is required, both curves shift upward, though not necessarily by the same amounts. However, the plant will continue to operate only if the revised net present value of the plant exceeds the initial outlay, or investment cost, of pollution abatement.

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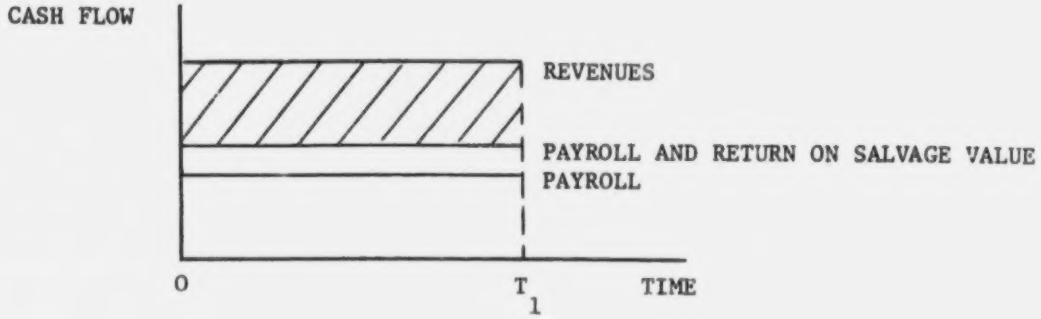
[1] An adjustment must be made for salvage value. See Appendix A.

An estimating procedure was developed as follows. First, out-of-pocket expenses were assumed to be a specific proportion of revenues; i.e., the ratio of payroll to value added for the group of obsolescent plants under consideration. To the payroll was added an estimate of the return to capital expected if the plant were scrapped.[1] For the model plant, an arbitrary life span is assumed. The failure rate for industry, when projected, indicates

FIGURE 2



how many plants will close each year. Consequently, the arbitrary life span for the model plant is increased until net present value exceeds the initial outlay, or investment cost of pollution abatement, an estimate of the number of closures is obtained. This figure is multiplied by employment per plant to estimate the resulting unemployment.

Because the rectangle of Figure 2 is only a gross approximation to the shape in Figure 1, a sensitivity analysis is carried out by varying the magnitude of pollution abatement costs (i.e., by applying larger or smaller cost estimates to determine whether conclusions are significantly affected by such variation). If the resulting variation in probable number of closures (and associated unemployment) is significant, and provided that figures for the economy as a whole are excessively broad for policy purposes, then EPA might commission a specific study which would estimate unemployment more precisely.

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[1] An over estimate is used here to reduce the size of the estimated discounted cash flow (Figure 2) and therefore overestimate the likelihood of plant closures.

Labor Intensive Industries

Since plants in labor intensive industries have (by definition) very little capital invested, it is not easy for them to compete with a more efficient plant by accepting a lower return to capital. It is much more likely that such a plant will curtail its market, giving up its distant customers to a more efficient competitor, and dropping its least profitable products. Plants in labor intensive industries, then, signal their likelihood of closure by reducing output and employment by substantial amounts over a period of years, reflecting the gradual erosion of their protected market.

This means that the ratio of payroll to value added is much less variable for plants in a labor than in a capital intensive industry. Consequently, the industry average is used for estimation purposes. Otherwise, the estimation procedure used is the same as for a plant in a capital intensive industry.

Differential Pollution Abatement Costs

Two reasons for differential costs of pollution abatement are discussed here: economies of scale for pollution abatement equipment, and the possible high cost of abatement for obsolescent plants.

Appendix B considers a third reason for differential costs: varying legislative requirements by state and country.

It is assumed that different plants within an industry will be required to make roughly proportionate reductions in pollution. This assumption will not be universally valid; abatement legislation may be sufficiently flexible to ease requirements for small plants. If so, differential costs as computed in this study may be reduced, even to insignificance.

It should be noted as well that differential costs of pollution abatement relate primarily to different relative initial capital outlays. Two reasons are here advanced for this stress.

First, most operating and maintenance costs tend to be proportional to the use of abatement equipment, and therefore, to a more limited extent, to plant output. One example of costs that vary in direct proportion to production is the substitution of fuels that cost more for fuels that pollute more. Fuel combustion tends to bear a direct relationship to output. Some of the pollutants -- for example, particulate matter and sulfur oxides -- can be reduced by changing to fuels (such as natural gas) which emit less of the pollutant. The cost per unit of production, then, will be insensitive to both size and age of establishment. Similarly, unless the technical processes differ substantially, other operating and maintenance costs will not differ significantly in relation to output among plants within an industry.[1]

Second, as outlined in Chapter 1, The Problem Defined, it is the initial decision to abate or to cease operations that is of interest. The plants which *do* abate, will, if anything, tend to employ more workers and to produce for a longer period of time than if the industry had not faced a requirement to abate.

The cost of capital equipment for pollution abatement, on the other hand, does not tend to increase proportionately with output. The costs are incurred initially as *fixed costs*, and little can be recouped if production diminishes or ceases.

In industries where a large portion of total annual costs consists of the annualized costs of the initial capital outlay, differential of pollution abatement costs may well be substantial. For example, air pollution control increases the cost of castings made in large gray iron foundries by only 0.7 percent, while the increase is 3 percent for castings made in single cupola foundries.[2] There are two basic reasons for differential costs of pollution abatement equipment: different plant size and different ages.

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[1] Production of lime, for example, results in considerable emissions of particulate matter, especially from the newer rotary kilns. One with a daily capacity of 400 tons, requires a venturi scrubber with investment cost of $30,000 (i.e., $6,000 per year) but operating and maintenance costs of $39,000 per year. Consequently, the differential impact of air pollution abatement within the industry will be minor. See Report of the Administrator of the Environmental Protection Agency, *The Economics of Clean Air* (Washington, D. C.: GPO, March, 1971), p. 4-87.

[2] *Economic Impact of Air Pollution Controls*, U. S., Department of Health, Education and Welfare (Washington, D. C.: GPO, August, 1970).

It has been assumed that all plants within an industry are required to install appropriate equipment to abate. This may not always be true where water pollution is concerned. Small plants are frequently allowed to hook up to municipal sewage treatment plants. Their investment costs are, therefore, converted into operating costs; hence, in conjunction with economies of large scale associated with municipal plants, differential costs may be eliminated.

Plant Size

Small plants tend to have relatively high costs of pollution control when expenditure on equipment is a major portion of the bill. Building a small piece of equipment usually requires as much skill, expertise and labor as a larger unit. Thus, while costs for large and small plants may be fairly close, the available capacity and hence the quantity of goods produced by each are very different. Consequently, the larger establishment obtains equipment at a much lower cost per unit output than the smaller.

Since labor intensive industries tend to serve local markets, plants vary in size according to their location. By contrast, when an industry requires significant capital outlays, plants are fairly uniform in size because the concomitant economies of scale tend to override the advantages of conforming to requirements of specific markets.

If a labor intensive industry is required to make a significant investment in pollution abatement equipment, the new entity (i.e., after pollution abatement) is more capital intensive than before.[1] This means that as a new equilibrium for the industry develops, plants will tend to become more uniform in size. In essence, economies of scale for pollution abatement equipment favor the larger plants.

Local market orientation may be the result of either product differentiation or high shipping costs. In the former case, there are advantages in locating different plants near one another, called economies of agglomeration. For example, a pool of trained workers can be built up in a given area, and potential buyers can visit several plants before making up their minds.

If one plants closes, its business (and employees) will quickly be absorbed by its competitors. If the management of a plant feels that pollution abatement costs will force it out of business, a merger can often be effected with another firm in similar circumstances, so that the costs of pollution abatement to the combined concern will be reduced.

High shipping costs in an industry lead to differences in plant size because regional markets vary considerably in their total

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1. The assumption here is that all plants will have to use essentially the same kind of equipment (i.e., abate by approximately the same percentage). If less is required of small plants, differential costs will be less important.

demand.[1] Typical examples of industries with high shipping costs are gray iron foundries, brick and tile, and bottling plants. Large producers are often located in or near large cities, with smaller plants supplying the smaller communities, and each faces competition from only a limited number of sources.

It is interesting to note that in many of these industries, recent changes in transportation have already disrupted existing markets, forcing some plants to close. In particular, the Federal Interstate Highway system has considerably reduced the cost of trucking.[2] As a result of improved highways, some large plants have been able to expand their operations and encroach on the protected (i.e., isolated) markets previously served by small local plants.

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1. A number of economists have linked shipping, or transportation, costs to the number and size of establishments in a given industry. One of the best treatments is given, for retailing, in W. Arthur Lewis, "Competition in Retail Trade," Overhead Costs (London: George Allen & Unwin, Ltd., 1949), pp. 116-156. Other include Harold Hotelling, "Stability in Competition," Economic Journal, Vol. 39 (March, 1929), pp. 41-57; A. P. Lerner and H. W. Singer, "Some Notes on Duopoly and Spatial Competition," Journal of Political Economy, Vol. 45 (1937), pp. 145-186; Walter Isard, Location and Space Economy (New York: MIT Press, 1956), pp. 77 ff; and William S. Vickrey, Microstatics (New York: Harcourt, Brace & World, Inc., 1964), pp. 323 ff.

2. "Since construction began, fifteen years ago, the Interstate has changed life and work, for better or worse, over much of the nation." "If anyone had realized the sheer magnitude of the interests affected by this road system," says Moynihan. . ., "it is impossible to imagine that it would ever have been built." "The engineers who designed the system in the late 1930's were certainly oblivious of the social and economic implications of what they were proposing, as were Congress and President Eisenhower, who put the plan into motion in the 1950's." Juan Cameron, "How the Interstate Changed the Face of the Nation," Fortune (July 1971), p. 80.

This market expansion[1] has often enabled larger plants to undercut the prices of their smaller rivals and some of the smaller plants have had to close down or merge in order to compete. Thus (although differences in size may still by substantial), the number of plants has been reduced during the past decade and yet there has been no specific federal response to this situation.

Required investment in pollution abatement equipment can affect an industry in similar ways, but the effect will be smaller in magnitude and of shorter duration than those resulting from the expansion of the highway system, principally because when the capital intensity of an industry is changed (as opposed to shipping costs), the larger plants do not expand much. Instead, they tend to raise prices and accept a greater profit per unit. But there are some very small plants with exceptionally high costs of pollution abatement which may not be able to survive. First, because their prices are already high; second, labor is unlikely to accept lower wages and, third, mergers are not attractive since shipping costs are high. If these small plants are to be kept in operation, a substantial proportion of these differential costs would have to be absorbed on a continuing basis by equity holders. In practice, this is not likely to happen and these plants will cease operation unless they receive assistance.

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[1] See, William S. Vickrey, Microstatics, (New York: Harcourt, Brace & World, Inc., 1964), p. 334.

Plant Age

Old plants may incur relatively higher abatement costs than others. First, they have generally not been designed in a manner which would permit easy installation of pollution control equipment. This means that space might have to be created by moving other equipment and/or buying new (frequently high priced) land adjacent to the factory.[1] Alternatively, a higher-priced type of equipment must be used because it needs less space. An electrostatic precipitator, for example, requires more space and electric power than a fabric filter; the installation cost of the former must therefore include costs of making available the necessary space and electric power supply. In these cases, installation costs are augmented by the necessity for more instrumentation, design engineering, and labor.

Existing recovery and disposal systems may need extensive rebuilding to accommodate the new equipment.[2] When a plant has been built with no thought of controlling waste disposal, it may be difficult even to find, and more so to eliminate, many of the discharge points. If the technology is obsolete, it may often be accompanied by a greater degree of pollution, reflecting the general inefficiency and wastefulness of the technology.

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[1] One source noted that the limited size of the mill site at the U. S. Plywood-Champia pulp plant in Canton, N. C. necessitated installation of compact water treatment which was more costly but less extensive than the lagoons treatment. The Council on Economic Priorities, Paper Profits: Pollution in the Pulp and Paper Industry, 1971, p. V-8. (Mimeographed.)

[2] The extraordinary costs of the Bethlehem basic steel making facility at Lackawanna, N. Y., one of the nation's oldest, is among the cases recounted in a recent comprehensive survey of industrial pollution abatement costs. See Gene Bylinsky, "The Mounting Bill for Pollution Control," *Fortune*, July 1971, p. 130.

The higher costs of abating pollution are, of course, partly caused by management having ignored environmental issues in the past. Some firms have installed pollution abatement equipment before they were required. A number of firms have gone far beyond present requirements, or have designed plants so that the necessary equipment can be added later.[1] Thus, many old establishments are forced into heavy expenditure while others have already installed most of the necessary equipment.

Differences in pollution abatement costs, on the basis of plant age, may occur either because of the difficulties of incorporating pollution abatement equipment among old equipment which might have to be moved or rebuilt, or for the related reason that different production processes are in use.

It is unlikely that two processes would be discovered, each with precisely the same costs and capital-labor ratios, and so the reason for employing more than one process in capital intensive industries is that one is older than the other. Usually, an innovation requires less labor (and possibly less capital) because historically the real cost of labor has risen. This means that a new process involving a reduced labor force becomes attractive as wage rates increase, and, over a period of time, all new plants will use the same new process. As wage rates continue to rise, the older and relatively labor intensive plant (in the sense of high payroll compared to value added) becomes costly to operate in relation to the new. This means that the net worth of plants using the older process declines year-by-year as their labor costs rise. Eventually, labor costs are so high that there is no return to the capital invested, and the plant is closed.

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[1] One source indicates that Weyerhauser has been a leader in pollution abatement since the early 1950's. Consequently, their expenditures on pollution abatement in the coming decade will be far less than some of their less concerned competitors. The Council on Economic Priorities, Paper Profits: Pollution in the Pulp and Paper Industry, 1971. (Mimeographed.)

In a relatively capital-intensive industry, it is quite usual to use a number of processes. The plants employing the most obsolete processes may well have difficulty in absorbing high pollution costs, since there is so little return over and above payroll and the cost of supplies.

It is conceptually possible to find out how many such plants exist by determining the number which have very low return to capital. This information is not presently available from the Bureau of the Census, however, so it may be necessary to obtain the information from other sources or by means of a special study. It would also be necessary to determine if the pollution abatement cost for this group significantly exceeds the industry average before deciding how many might fail. Again, if a number of these plants were failing already, the rest might have to compare the total investment cost of pollution abatement to their earning prospects in the years before failure.

This chapter concludes the outline methodology designed to predict unemployment caused by the closure of plants that have become economically non-viable as a result of pollution abatement requirements. In addition, as discussed in the following chapter, unemployment may result from plants closing merely because they cannot obtain loans from commercial sources. The three case studies in Chapter 5, have been prepared to illustrate the procedures developed to estimate unemployment in both types of situation.

CHAPTER 4

THE PROBLEM OF FINANCING AND EVALUATIVE CRITERIA

Summary

1. The number of potentially viable plants, i.e., those which could pay for pollution abatement but cannot obtain commercial financing, is very small for the following reasons:

a) Many small plants are, in actuality, owned by prosperous multi-plant corporations, and therefore have access to funds.

b) Many others will be able to finance abatement through internal reserves, or, in closely held companies, by increasing stock.

c) Others again have been in business a long time and have established a credit relationship with one or more financial institutions.

2. Nevertheless, there are two possible reasons why some plants may be potentially viable in the above sense:

a) Rigid bank lending practices may fail to take account of the plant's ability to recover the costs of abatement by increasing prices. The number of such plants is limited by the fact that enforcement generally starts with the largest concerns. In this way, prices have often begun to rise before the smaller plants start to abate. Moreover, as the non-viable plants cease operations, prices will tend to increase anyway.

b) Unfounded prejudice. Despite a prevalent belief that small businesses are apt to be victims of unfounded prejudice, evidence on this score is so weak as to preclude estimation of the number of plants that might conceivably be affected.

3. The Small Business Administration has been set up to provide loans to small businesses and has the authority to make loans for pollution abatement. The would appear to be no reason why the Environmental Portection Agency should set up an additional program.

Evaluative Criteria

When funds are not available internally, a firm must seek financing from outside sources. This may not be an easy matter, since management must convince an often skeptical outsider that the plant's (or firm's) prospects for the future are sound. The fact that costs of pollution abatement are relatively easy to determine[1] is an advantage to the potentially viable plants under discussion in this chapter.[2]

The assumption that commercial financing is available to all viable firms presupposes certain conditions. The financial community must be able:

1. To predict the number of viable plants in each industry
2. To determine which plants are viable, and

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[1] Pollution abatement is comparable to process innovation in a number of respects. First, the cost to the firm can be estimated in advance. Second, process innovations, unlike product innovations, are likely to succeed, because the firm has better control over all aspects of the operation. Third, they generally involve 'standard' machinery and techniques that other firms have used in similar situations. For all these reasons, pollution abatement is not a speculative investment and is therefore easier to finance.

[2] Obviously a government loan could only be an appropriate form of assistance in cases where there was a likelihood that it would be repaid. In other words, loans are only suitable for potentially viable, as opposed to non-viable, plants.

3. To act in an economically rational manner, that is, be willing to make loans to all potentially viable plants.

To investigate the details of every loan application would be a costly and time-consuming operation and therefore lending institutions employ a number of evaluative criteria as a first means of accepting or rejecting different types of businesses. The criteria may vary to some extent among institutions, but once lending practices have been established, they are usually adhered to fairly strictly. Possible applicants are isolated by these methods in the first instance and each is then subjected to a more rigorous investigation before being finally accepted, particularly so in the case of marginal firms.[1]

General considerations include first, the borrower's credit rating, and especially performance relating to any previous loan made by the same institution. Second is the location of the plant. Banks usually accept clients only from within their own community where information pertinent to the loan can be readily collected and the significance of changes in the community can be assessed. If a bank is large enough to support a great many loans, it has the advantage of being able to subdivide applicants into different industrial groups and thus utilize information about the industry to predict the effects of new trends on an individual plant.

Two fairly broad types of evaluative criteria are generally employed to assess the viability of an individual applicant: payback ability and liquidity.

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[1] "Marginal" is used here to describe those firms which do not conform to generally accepted evaluative criteria.

Payback Ability

The profit and loss statement of a plant provides a ready means of estimating payback ability. The absolute level of profits indicates whether or not a plant is capable of generating funds, although the significance of this information diminishes with age. Erratic profits over a number of years imply a lack of stability and a danger of bankruptcy and the plant is therefore generally classified as a high risk.

Projections of sales and profits are required and their relation to past growth as well as future prospects is also important.

Liquidity

A second consideration is the liquidity position of the potential borrower. If the plant were to close, the lender would obviously be better off with a plant that had a considerable excess of assets over liabilities. (This would be true even is the plant were to experience difficulties in generating the predicted revenues.) The debt-equity ratio is the first specific criterion used to establish the potential capital available if the plant should close. The current ratio (current assests/current liabilities) indicates the ease with which the plant can meet current obligations. The cash flow can be used as an aid in predicting changes in the stock of capital available.

Many other aspects of the plant's operation will be investigated, not the least important being an appraisal of management capability, before an applicant can expect to qualify for a loan.

Many commentators have contended that these rule-of-thumb procedures have led banks and other financial institutions to make fewer loans to small business than are warranted, and that the possible risks involved in lending to small business should be more carefully scrutinized. In other words, it is frequently believed that unfair discrimination is practiced against small business. One recent study concludes that "the availability of long-term and equity capital cannot be considered adequate",[1] while another authority states that,

> . . . There seems to be little doubt that in this competition (for financial resources) the small business is under certain disabilities that do not equally affect its larger counterpart: it is more likely to need money; its choice of sources is more limited; the terms are generally more burdensome in respect to security, interest, and maturity.[2]

At first glance, many facts may seem to support this contention. For example, as Table 4-1 shows, small businesses generally have poorer credit ratings than large firms and new businesses have a lower rating than old ones.

Banks generally prefer short-term to long-term loans. According to the last complete survey of banking (1957), only 19 percent of all commercial loan money was lent for periods of over five years,[3] and only a small part of this long-term money went to firms with assets under $1 million. Tables 4-2 and 4-3 show

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[1] Harold T. Smith, Equity and Loan Capital for New and Expanding Small Business (Kalamazoo, Michigan: W. G. Upjohn, 1959), p. 5.

[2] Edward D. Hollander and others, The Future of Small Business (New York: Frederick A. Praeger, Publishers, 1967), p. 129.

[3] Harold T. Smith, Supra, p. 34.

Table 4-1 [1]

INDEX OF RELATIVE TRADE CREDIT STANDING OF BUSINESS BY SIZE AND AGE

(The proportion of businesses with good credit in the surveyed populations = 100)

Age Classes	Size Classes			
	All Sizes	Small	Medium	Large
All ages	100	97	108	129
Under 5 years	88	86	97	NA
5-10 years	97	96	101	NA
Over 10 years	105	102	111	129

Source: A statistical study of data on credit standing of a large and representative sample of business firms conducted for Robert R. Nathan Associates, Inc.

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[1] Edward D. Hollander and others, The Future of Small Business (New York: Frederick A. Praeger, Publishers, 1967), p. 130.

that for the year in question only a small proportion of the loan money available from commercial sources went to small business and that the proportion became even smaller as the term of the loan increased.

One common reason for a low credit rating is that management has not yet had time to demonstrate competence in running a new operation. One source notes:

> Among the business births each year. . .about one third will live to age five and about one fifth to age ten, after which the survivorship rates from year to year are very high. From this point on, deaths are from 'natural causes': The sale of the business as a going concern; liquidation because of retirement, death, or other personal reasons; the termination of a lease or forced removal; etc.[1]

Since most new businesses are small, the selection criteria will tend to be biased against small business.

The smaller plants in any given industry are apt to be located in small towns or rural areas. Consequently, they have the disadvantage that they are usually dependent on small banks and, as one source notes:

> By any objective standard, the small banks appear to be an economic anachronism. They are overliquid and overcautious. Their business lending is usually confined to long-established customers. Many are also painfully understaffed and unequipped to handle a complex or unusual loan request. In general, the small banks serve their local communities very poorly.[2]

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1. Edward D. Hollander and others, The Future of Small Business (New York: Frederick A. Praeger, Publishers, 1967), p. 107.

2. Sanford Rose, "Are Those 11,400 Banks Really Necessary?" Fortune, November, 1970.

Table 4-2[1]

DISTRIBUTION OF TOTAL BANK COMMERCIAL LOAN MONEY -- 1957

Term of Loan	Small Business	Large Business	Total
Under 1 Year	21.0%	41.0%	62.0%
1 - 5 Years	5.7%	13.3%	19.0%
Over 5 Years	5.1%	13.9%	19.0%

Table 4-3

PROPORTION OF BANK COMMERCIAL LOAN MONEY GOING TO SMALL AND LARGE FIRMS ACCORDING TO TERMS OF THE LOANS -- 1957

Term of Loan	Small Business	Large Business	Total
Under 1 Year	34.0%	66.0%	100%
1 - 5 Years	30.0%	70.0%	100%
Over 5 Years	27.0%	73.0%	100%

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1. Tables 2 and 3 were based upon material cited in Harold T. Smith, Equity and Loan Capital for New and Expanding Small Business (Kalamazoo, Michigan: W.E. Upjohn Institute for Employment Research, 1959), p. 34.

Larger banks are more productive, can offer a wider range of services and can adopt a more flexible attitude with regard to loans than smaller banks which cannot afford to risk the failure of even a small number of loans.

These remarks can be formalized by listing four reasons which may contribute to low credit ratings given to small firms. It should be recognized, of course, that the first two are valid market considerations (and the third, misinformation, might be justified as well) which combine to discourage banks from lending to small businesses.

1. Borrowing costs
2. Uncertainty
3. Misinformation
4. Irrational prejudice

Borrowing Costs. These costs are incurred when the lender is obliged to investigate a loan application and may be considerable in the case of a new business without an established credit rating. However, as plants affected by pollution abatement requirements have generally been in existence for some time, this should not be a serious problem here.

Uncertainty. Small firms are often closely tied to a few suppliers and a few principal customers. Any change in the pattern of dealings with one of the suppliers or customers can have a major effect on the firm's profits. Thus small plants are likely to have a more volatile profits record than large firms and are more liable to go bankrupt in adverse business conditions. This uncertainty represents a serious risk from the lender's point of view.

Misinformation. In most instances, lending practices have been built up over a number of years and financial institutions are reluctant to depart from established precedents. The disadvantage of this system is that established procedures may be inadequate to assess an unusual or a new situation. For example, victims of natural disasters have often experienced great difficulty in borrowing money from their local banks to restart their businesses because they were in an unusual situation which had not been envisaged by the bank in devising a framework of lending practices. This problem was so serious when it did occur, that the Small Business Administration[1] has a program to provide funds in these circumstances.

Pollution abatement regulations present a new situation insofar as similar legislation has never before been enacted. Consequently, applications for loans may be rejected by banks because the effects of industry-wide prices on the prospects of an individual plant are imperfectly understood. In fact, the effect will be the same as that of an excise tax.

Irrational Prejudice. In view of the above discussion, it seems probable that accusations of irrational prejudice are unwarranted. Indeed, a Federal Reserve study supports the position that such prejudice is minimal.

> ...bankers tend to subject almost all borrowers to the same general test of credit-worthiness,

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[1] For a further discussion of the Small Business Administration, see below and Chapter 6.

> but they have found from experience that certain lines of business and types of collateral offer possibilities of greater risk than others.[1]

Edward D. Hollander suggests that, by and large, the general criteria used by financial institutions may miss some special cases, but feels that "tightly individualized evaluations" would be needed to "distinguish the promising prospect from the inherently poor risk."[2]

This comment can be explained if small plants do indeed involve a higher risk than large firms. In each case the observed variance could partially be explained by information about the individual concern. If the overall variance is small, the additional information will have little effect in separating the good risks from the bad. But if the overall variance is large, it is much more likely that more intensive investigations will bring to light plants that are potentially viable.

Short-Term Effect

In any case, assuming that irrational prejudice may exist to some extent, it would result only in a short-run or transitional problem. If financial institutions are too conservative and inflexible in their lending practices, an exessive number of business failures may occur among potentially viable firms and the resulting unemployment would be a cost to society unless the factors of production could be shifted immediately to other industries.

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[1] U.S. Congress, Select Committee on Small Business, Financing Small Business, Report to the Committees on Banking and Currency by the Federal Reserve System, April 1958. Cited in Edward D. Hollander, et al, The Future of Small Business, (New York: Federick A. Praeger, Inc., 1967), p. 129.

[2] Edward D. Hollander and others, The Future of Small Business (New York: Frederick A. Praeger, Publishers, 1967), p. 135.

In the meantime, however, the supply of the product is reduced by more than the optimum. The shortfall will induce an increase in price as suppliers discover that price resistance has lessened. The price increase will be faster than in optimal conditions, and the rapid improvement of the industry's situation will prompt a new assessment of firms' prospects. In other words, new plants will be started sometimes by the same people who were previously refused loans, but whose prospects have now improved owing to the new, higher prices for the product. Activity of this kind is well established in "folding table" businesses in construction and repair industries where both capital and scale are so small that operators can move into and out of business with equal facility.

As well, enforcement usually begins with large companies: as they abate, prices rise, i.e., even before small plants abate.

All of the problems referred to above concern the economy as a whole, and a practical solution would require a general program rather than piecemeal enforcement by individual agencies whose main interests and competence lie elsewhere. In fact, the Small Business Administration was funded for the purpose of circumventing some of these problems and is concerned with the question of financing small businesses which have been unable to draw on commercial sources. Consequently, this agency is better informed about conditions in any given industry than most banks (especially small town banks), is able to consider individual cases more carefully, and can thus evaluate doubtful prospects more precisely than a commercial institution. In the circumstances, it would seem unneccessary for the Environmental Protection Agency to set up a special program to handle the loan applications of potentially viable plants, especially as they are expected to be few in number.

CHAPTER 5

CASE STUDIES

The following three case studies have been prepared for separate consideration so that each may stand alone and provide comprehensive information without reference to companion pieces. Since the same, or similar, factors are being considered in each case study, the repetition of a number of statements is inevitable and deliberate.

The studies concentrate upon the costs of air pollution only; full studies of all connected and ancillary costs relating to other forms of pollution control do not come within the scope of the present contract but would, of course, have to be included in an actual survey of the economic effects of pollution control legislation upon industry.

Chapter 1, Methodology (Part I): Outline, should be read before the case studies. Very briefly, the salient points to be noted are as follows:

1. Plants will abate unless the initial outlay involved exceeds the discounted cash flow less salvage value of the plant.[1]

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[1] This can be expressed mathematically as follows:

$$PA > DCF + \Delta DCF - S$$

where PA = initial outlay for pollution abatement,
DCF = anticipated discounted cash flow prior to abatement regulations,
ΔDCF = change in discounted cash flow because of abatement regulations, and
S = salvage value of plant.

2. Accuracy in estimating plant closures within a particular industry is not important since the major problem for policy purposes is to estimate the nationwide impact on employment. Only if the latter range of estimates is too broad to decide upon an appropriate federal response, need more accurate estimates be made for specific industries.
3. A crude estimation procedure based on readily available data is proposed as being the most immediate and cost-effective means of estimating the magnitude of unemployment resulting from pollution abatement legislation. It will indicate the range within which closure can be expected within a given industry.

   By summing the low and high estimates for closures in each industry, a broad range can be determined for the economy as a whole. Some plants will be situated in areas of chronically high unemployment and it will be advisable to determine the geographic locations of closing plants for the industries most affected.
4. (a) Prices will increase rapidly if industry control is concentrated, if demand is price inelastic, or if the industry is labor-intensive. In the latter instance output may decrease if demand is price elastic.

(b) Price increases will be delayed if demand is price elastic and the industry is capital intensive with excess capacity.

5. (a) Plants may cease operations if they anticipate operating for only a few years. An estimate is given for the period of time required to recoup investment in pollution abatement.

(b) Plants may also cease operations if their differential cost of abatement is sufficient to exceed the anticipated net present value of the plant.

6. Separate case studies have been prepared for industries which are labor, capital and resource intensive because consideration of these extremes is essential to the discussion. (It should be recalled that processes used in resource intensive industries are either labor or capital intensive.)

CASE STUDY #1: GRAY IRON FOUNDRIES

Objective

This section illustrates the application of the methodology developed to estimate the order of magnitude of unemployment in a labor intensive industry. The data are, in many cases, incomplete or outdated and therefore are used for illustrative purposes only.

Context

The gray iron foundry industry has been selected as an example of a labor intensive industry since its payroll (at $956 million) is 63 percent of value added (at $1,543 million),[1] well above the 47 percent figure for all manufacturing (Table 3-1). In addition, the major portion of costs of materials[2] (of $1,075 million) is for supplies of pig iron. Yet, the industry calls for such a small proportion of the total supply available in the U.S. that an increase or decrease in the output of foundries does not affect the price of pig iron. Consequently, for analytical purposes, even the cost of materials can be considered akin to labor in that its price is unaffected by changes in foundry output.

Industry Economics

Gray iron foundries produce castings for diverse purposes. In most cases castings have low value per unit weight, with high transportation costs in relation to this value. Market size is therefore largely dictated by transportation costs. Indeed, there are approximately 1,000 plants of widely varying size.[1] The potential effect of differing regional or international regulations is thus minimal.

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[1] Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol. II (Washington, D. C.: GPO, 1970), Table 4, "General Statistics, by Employment Size of Establishment: 1967" (SIC 3321)

[2] Cost of materials is only $1,075 million, or 41 percent of the value of shipments of $2,738 million. Ibid.

Closures of small plants occur when transportation costs increase or when a more capital intensive process is developed. In each case, larger plants are able to expand their markets at the expense of smaller ones. The failure rate for gray iron foundries has been about 25 a year for the past ten years (2-1/2 percent of the industry per year).[2]

The real growth in the gray iron foundry value of shipments was 5.4 percent per annum from 1958 to 1967. This is similar to the real growth of value of shipments of all manufacturing of about 5.5 percent.[3]

Pollution Abatement Costs

Gray iron foundries emit carbon monoxide and particulates; abatement equipment consists of afterburners and wet scrubbers or fabric filters. By 1976, it is estimated that the industry will have invested $317.3 million to achieve pollution abatement.[4] Once this investment has been made the annual cost to the industry will be \$108.2 million.[1] Part of this represents amortization of the investment cost (\$63.6 million);[2] all the remainder represents annual operating and maintenance costs (\$44.6 million).

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[1] In 1967, there were 1,061 plants. Of these, 126 employed no more than four workers, while five employed more than 2,500.

[2] Bureau of the Census, "County Business Patterns," cited in U.S. Department of Health, Education and Welfare, Economic Impact of Air Pollution Controls (Washington, D. C.: GPO, 1970), p. 76.

[3] U.S. Department of Health, Education and Welfare, Economic Impact of Air Pollution Controls on Gray Iron Foundries Industry (Washington, D. C.: GPO, 1971), Table 18, p. 46.

[4] Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D. C.: GPO, 1971), p. 4-112.

The study will utilize the following percentages of value of shipments, which is estimated at \$3.5 billion:[3]

Average annualized investment cost:	1.8%
Annual operating and maintenance costs:	1.3%
Total annualized cost:	3.1%

It should be made clear at the outset that each of these figures is being revised by EPA; moreover, costs of water pollution abatement, etc. are not included. The results therefore, may not be indicative of the actual number of closures.

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[1] Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D. C.: GPO, 1971), p. 4-112.

[2] If an amortization period of 10 years and interest rate of 14 percent are assumed, annualized costs are one fifth the initial cost. Ibid.

[3] Ibid., p. 4-20.

[4] U.S. Department of Health, Education and Welfare, Economic Impact of Air Pollution Controls on Gray Iron Foundries Industry (Washington, D. C.: GPO, 1971), Table 18, p. 46.

Economic Analysis

1.0 Price Changes

There are few barriers to raising the price of castings in response to an industry-wide increase in cost. First, castings have relatively few substitutes. In some cases aluminum could be used, but the pollution abatement costs for aluminum are even higher than for gray iron foundries.[1] On the other hand, castings are often complemented by other products in order to provide the final commodity (e.g., cars). Finally, castings are often a small portion of a customer's total budget; therefore, price changes are of limited concern. Demand for castings, then, is relatively price inelastic. Demand is particularly inelastic in the short run since any substitution would usually require a considerable period of time to effect. Consequently, customers will bear a large proportion of pollution abatement costs, even in the short run.[2]

Since gray iron foundries are labor intensive, it is assumed that supply is price elastic in both the short-and long-run. This means that the industry exhibits essentially constant unit costs over a wide range of output. In this special case of constant unit costs, the price, irrespective of quantity demanded, must rise by the full increase in the exogenous pollution abatement costs. Since the average annualized pollution abatement cost is estimated to amount to 3.1 percent of value of shipments (see Pollution Abatements Costs, above), the price is likely to rise by approximately the same amount.

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[1] Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D.C.: GPO, 1971),pp. 4-20.

[2] See Chapter 2.

The quantity demanded is determined (in the case of price elastic supply) by the price elasticity of demand for the product. Since demand is relatively inelastic, the reduction in value of shipments would be small, even in the absence of industry growth. Real output is increasing, however, by about 5.4 percent per annum. (See Industry Economics, above).

The established demand will prevent layoffs, as the price rises rapidly until the entire cost of pollution abatement, estimated here at 3.1 percent of value of shipments, is covered. Expansion will be deferred during this period of price absorption which is unlikely to last for more than a year or two altogether.

2.0 Differential Cost

Although most plants in the industry will have little trouble in passing on costs of pollution abatement, individual plants with high costs face a more difficult situation in that their customers may have access to cheaper alternative sources of supply, namely those plants with lower abatement costs. The differential will, therefore, have to be absorbed by the equity holders, who must decide whether to go out of business or to accept the increased cost burden.

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1. Those plants whose costs are lower than the average may of course, profit by the regulation. See Chapter 3.

If a plant does go out of business, there may be additional transition costs which the community as a whole must bear, principally the cost of prolonged unemployment for the workers concerned.

2.1 Cost Differentials for Foundries

There are three major reasons for differential costs: size of the plant, processes employed and legislative requirements. The two latter causes are discussed at length in Chapter 3 and Appendix B. The question of size is the more important of the three and the only one pertinent to this case study.

Annualized investment costs for pollution abatement are estimated to vary from 0.7 percent of value added for large foundries to 3.2 percent for the smallest plants. But the industry's average annualized investment cost of pollution abatement is 1.8 percent of value of shipments. (See Industry Economics, above). This figure provides a rough approximation to expected price increases. Since large foundries have lower costs, we can overstate the probable damage by assuming that, at worst, they may have an increased return or profit of 1.1 percent once prices have fully risen, while small foundries will suffer a permanent loss of up to 1.4 percent (i.e., 3.2 percent less 1.8 percent, the average) of the value of shipments.[1] For purposes of discussing whether small foundries will decide to accept this cost, or go out of business, they are classified as being "long-run" and "short-run" viable before investment in pollution control.

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[1] The provisions of the corporate income tax will reduce both profits and losses.

2.1.1 Long-Run. Before deciding whether to absorb the 1.4 percent annual cost or to go out of business, management must estimate the difference between actual return to capital (i.e., before pollution control investment) and the potential return to this capital in alternative uses (i.e., the opportunity cost of the capital employed). If this difference is greater than the pollution abatement cost, the plant will install the necessary equipment. Once this capital is committed, it will have no further effect on the plant's actions. A rough estimate of the gross return on capital in gray iron foundries was calculated from 1967 Census of Manufacturing data as 22 percent of value of shipments.[1]

Financial statistics providing a guide to salvage value are not available on a 4-digit SIC industry basis. Nevertheless, a rough estimate can be made: the building and land, for example, can probably be converted to alternative uses. Beyond that, however, the salvage value of the operation (plant, equipment, good will) would appear to be negligible. At a conservative estimate (in order to overstate closures),

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1. The total value added for the industry is $1,543 million. The total payroll of $965.3 million is subtracted from this, leaving a total of $577.8 million for the gross return on capital. This residual is now divided by the industry value of shipments of $2,637.8 million; the residual is 22 percent of the industry value of shipments. Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol.II (Washington D.C.: GPO, 1970) (SIC 3321).

it is assumed that the plant would lose a net return of roughly 10 percent of the value of shipments by ceasing operations.[1] Since this figure is much greater than the necessary expenditure on pollution control (i.e., by the very smallest plants, of 1.4 percent of the value of shipments), long-run viable plants will have no reason to close down.

2.1.2 Short-Run. A different analysis must be employed for plants which will cease operation in the near future even without incurring pollution abatement costs. In such situations, the costs cannot be looked at in terms of annual costs since these plants will not remain in operation for the 10-year estimated life of the equipment upon which the costs are calculated.

The highest annualized investment cost is estimated at 3.2 percent of value of shipments. That is equivalent to an initial investment of 16 percent of one year's value of shipments.[2] It may be that none of this capital cost can be recovered in the first year, but thereafter recovery is estimated to be at the rate of 1.8 percent per year, i.e., the average cost of capital for the industry (see 1.1 above).

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[1] Internal Revenue Service (IRS) data for the comparable 2-digit SIC industry (Primary Metal Industries) indicate that the sum of rent, interest and taxes in 1967 amounted to $1,768 million, or about 4.4 percent of business receipts of $40,154 million. U.S., Department of the Treasury, Internal Revenue Service, Statistics of Income, 1967: Business Income Tax Returns (Washington, D.C. : GPO, August, 1970), p.9.

This figure (4.4 percent) probably understates the return which could be made in an alternative use, particularly for the smaller, failing establishments with which this study is concerned. To be on the conservative side, then, the figure has been increased to about 12 percent, leaving a return above opportunity cost of about 10 percent.

[2] The investment cost was obtained originally as a dollar cost. This was annualized by dividing by five (interest rate of 14 percent, and amortized over 10 years).

The current closure rate is approximately 25 plants per year, (see Industry Economics, above), and all the failures are small plants. Assume that the 25 plants destined to close within a year in any event consider the alternatives of installing equipment or ceasing operation immediately. According to the rough estimates given in 2.2.1 above, net return to capital from continuing operations that would otherwise be lost is about 10 percent of the year's sales. The increased cost of operating for the first year as a result of installing abatement equipment is 16 percent of sales. It is reasonable to conclude that the 25 plants with a potential life of no more than one year would close immediately.

The 25 plants with an estimated life of two years will have a net return over that period of 18.77 percent[1] of one year's sales by remaining in business, while incurring costs of 14.32 percent[2] for abatement. Since the equivalent of 18.77 percent of one year's sales is lost if operations cease, most of this second group will have a limited incentive to continue.

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[1] 18.77 percent is equal to a return of 10 percent of the first year's sales, plus 10 percent of the second year's sales; the latter figure is discounted at the rate of 14 percent (i.e., the discounted figure amounts to 8.77 percent).

[2] 14.32 percent is equal to a cost of 16 percent of one year's sales for the initial investment, less (in the second year) 1.8 percent discounted at the rate of 14 percent (i.e., 1.68 percent).

In all, it may be assumed that some 35 plants will cease operations, and unemployment resulting therefrom would be perhaps 150.

3.0 Sensitivity Analysis

As a rough judge of the acceptability of these estimates, a sensitivity analysis can be performed by varying each number in turn to determine its effect on the overall conclusions.

3.1 Stability of Price Considerations

There is no reason to doubt the accuracy of the estimated average annual pollution abatement costs (3.1 percent of value of shipments). For the sake of the sensitivity analysis, however, an extreme case has been taken, and the assumption made that pollution abatement costs have been tripled for gray iron foundries -- i.e., 9.3 percent of value of shipments per annum. The incidence would be the same: prices would rapidly rise by 9.3 percent over an extended period of time. It is probable, however, that some employees would be laid-off temporarily (for a year or so), and for long-run viable plants (before abatement), the net impact would be reduced profits for several years.

The impact for short-run viable plants (before abatement) is rather different. Assume first that the absolute cost differential remains the same: small plants could lose about 1.4 percent of value of shipments permanently, in addition to the temporary losses described above. The cost for those plants having an expected life of only one year would increase to about 27 percent[1] of sales, a much higher figure than the 10 percent net return to be lost by ceasing operations.

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[1] The initial investment cost (27 percent) is five times the annualized investment cost of 5.4 percent.

Table 1 provides a rough illustration for comparative purposes. Plants with an expected two-year life will probably also close since the costs of pollution control would be larger than the potential gains from utilizing immobile equipment. Similarly, most establishments contemplating a three-year operation will close. On the average, the costs will be approximately as great as the financial benefits to be gained from continuing. A life span of four years or more is necessary before a plant has an incentive to continue under these circumstances.

Table GIF-1

SHORT-RUN VIABILITY[1]

Years of Operation	Costs Incurred[2]	Accumulated Costs[3]	Benefits[4]	Accumulated Benefits[3]	Net Incentive[2]
1	28.3	28.3	11.3	11.3	-17.00
2	1.3	29.44	13.1	21.79	- 7.65
3	1.3	30.44	13.1	31.87	+ 1.43

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1. All figures are expressed as a percentage of one year's value of shipments.

2. Initial investment cost is assumed to be 27 percent of one year's value of shipments. Each year operating and maintenance charges amount to 1.3 percent of the year's value of shipments.

3. Present value, assuming a discount rate of 14 percent.

4. Benefits include 10 percent of value of shipments (i.e., the return above opportunity costs) each year, and a price increase of 1.3 percent the first year and rising to 3.1 percent in succeeding years.

To summarize, when average costs are tripled, the number of closures caused by pollution abatement requirements is approximately doubled (i.e., from about 35 to about 70), with unemployment slightly more than doubled to just over 300. Even so, the average life of those plants which ceased operations would be cut by no more than two years.

3.2 Differential Pollution Abatement Costs

Estimation of the differential costs of pollution abatement is more susceptible to error than estimation of average costs. In order to assess the possible effect of such misestimation on the smallest foundries, an extreme case is postulated here, using tripled figures, i.e., it is assumed that annualized investment costs are 9.6 percent of the value of shipments rather than 3.2 percent.

For long-run viable plants (before abatement), it is here assumed that roughly 1.8 percent (i.e., the industry average costs) will be recouped, leaving an annual loss of 7.8 percent of value of shipments. Since this is somewhat smaller than the 10 percent net return per year (see 2.2.1., above), long-run viable plants will have some incentive to remain in business.

During their expected life span, short-run viable plants (before abatement) must recover the equivalent of an initial investment of 48 percent[1] of one year's value of shipments. Using the same method of calculating, a plant having an expected life of five years would incur a cost of about 40 percent of one year's sales for abatement but the cost would now be balanced by earnings. In short, when differential costs are tripled, the number of closures caused by pollution abatement requirements is increased four-fold from 35 to approximately 125, and unemployment increased five- or six-fold to say 1000.

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[1] 48 percent is five times the annualized investment cost of 9.6 percent.

This indicates that precise estimation of the costs of particular groups of plants, at least insofar as they substantially exceed the average, is important. Cost estimates for the gray iron foundries were developed by EPA using models of six different sizes of plants, the smallest having annual sales of $400,000.[1] About one-third of the existing foundries, however, are even smaller (some 350 plants); half of these have annual sales averaging only $30,000. For these plants, it seems unlikely that investment costs will decrease by the same factor as sales. In fact, one of the reasons for a low volume of sales is that some plants operate only sporadically, although their capital equipment may be as extensive as that of plants operating continuously and having a much larger annual value of shipments.

Although there are many small foundries, their output is so limited that it can be assumed that their increased costs will have little effect on the industry's average costs[2] or on price increases. Suppose that a plant with annual sales of $30,000 must invest half as much for pollution abatement as the model $400,000 annual sales foundry. The annualized investment cost would be at least 15 percent of sales. Obviously, in these circumstances a small foundry would close immediately. There are some 350 plants with annual sales of less than $400,000. It is clear that some, perhaps all, are liable to face costs that will force them out of business, but in the absence of more refined data it is not possible to provide a more precise estimate. In this extreme case, unemployment could range as high as, say, 4,000.

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[1] U.S. Department of Health, Education and Welfare, Economic Impact of Air Pollution Controls on Gray Iron Foundries Industry (Washington, D.C.: GPO, 1971), p.43.

[2] Thus, it can still be assumed that the increased price owing to the cost of pollution abatement will amount to 3.1 percent. (Pollution Abatement Costs, above).

3.3 The Effect of Misinformation

As outlined in Chapter 4, it is possible that financial institutions may reject applications for loans because they do not recognize that pollution abatement requirements in an industry will result in price increases. The effect of this misinformation might be that the entire cost of pollution abatement has to be borne by the plants themselves.

Small plants are therefore assumed to absorb an annual cost of 4.5 percent of value of shipments each year if they are to continue.[1] For long-run viable plants, it has been assumed that average net return is about 10 percent of value of shipments. While a permanent loss of 4.5 percent of value of shipments is large, there is still some incentive for plants to remain in business.

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1. Annualized investment costs are assumed to be 3.2 percent of annual value of shipments, while operating and maintenance costs run at 1.3 percent. See Pollution Abatement Costs and Cost Differentials for Foundries above.

For short-run viable plants the situation is different. At least two years' return would be required to offset the costs of pollution abatement. If 25 plants close every year, about 50 would close immediately rather than abate. This figure should be compared with the 25 to 35 plants which would close even if industry price increases were considered. (See Short-Run, above).

3.4 Uncertainty

The above discussion has concerned the number of plants which would close rather than pay specific levels of pollution abatement costs. A banker, however, must determine *which* plants will close. As pointed out in Chapter 5, this is particularly difficult when either price elasticity or cross-elasticity of demand is high. Neither appears to be the case for the gray iron foundry industry. If this assumption is correct, the effect of uncertainty is small.

3.5 Summary

Differential pollution costs are the most sensitive figures in establishing the number of closures likely to result from pollution abatement requirements. Information concerning one important category of plants (i.e., those with the smallest annual value of shipments) is not available for the gray iron foundry industry. If it is assumed that average abatement costs as a percentage of value of shipments for this category will not exceed the costs for the model with annual sales of $400,000, only 35 foundries will be immediately and directly affected. On the other hand, if investment costs, as a proportion of sales, rise even modestly as the size of a plant decreases, the number of failures will be considerably higher. In the absence of accurate information, one can reasonably speculate that approximately 350 foundries may be forced to close down.

In concluding, it should be re-emphasized that the figures cited above are for illustrative purposes only.

CASE STUDY #2: PORTLAND CEMENT INDUSTRY

Objective

This section illustrates the application of the methodology developed above to a capital intensive industry. The data are, in many cases, neither current nor complete, and are therefore used for illustrative purposes only.

Context

The Portland cement industry has been selected as an example of a capital intensive industry since the payroll ($248 million) is 30 percent of value added[1] ($812 million), well below the 47 percent figure for all manufacturing (see Table 2-1). Cost of materials ($493.2 million) is also a very small proportion of value of shipments, and the materials, including chalk, clay, limestone and shale, are readily available.[2]

Industry Economics

Portland cement is a binder in concrete and, therefore, the most widely used construction material in the U.S. It is produced by either a wet or a dry process, distinguished by whether the raw materials are introduced into the cement kiln as a wet slurry or as a dry mixture.

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1. U.S., Department of Commerce, Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol. II (Washington D.C.: GPO, 1970), Table 4, "General Statistics, by Employment Size of Establishment: 1967" (SIC 3241).

2. Cost of materials is just $493.2 million, or 35 percent of the value of shipments of $1,247 million. Ibid.

Since cement has low value per unit weight, transportation costs are high in relation to value. Markets are, therefore, restricted by transportation to a radius of 200 to 300 miles. There are 197 existing plants of which 115 employ between 100 and 249 workers;[1] since capital costs are high, size differences are not significant. The potential effect of differing regional or international regulations is minimal.

The trend in cement plants in recent years has been towards larger kilns, computerized operations and improved integration of the raw mill, the kiln, the clinker grinding and the associated storage and handling equipment. As wage rates have increased, the industry has continued to introduce labor-saving equipment. From 1963 to 1967, while output increased nearly 10 percent, the number of employees dropped from 34,900 to 32,400, a 7 percent decrease. During these years, the industry became more capital intensive and more efficient.

The new plants, therefore, can compete effectively with the older (in terms of price) because the newer plants have a greater percentage of their cost fixed as equipment and must employ it to earn a return. The older plants have greater proportionate variable costs; their labor costs are estimated to be three times those of the newer mills. The costs must be cut primarily through decreasing output.[2]

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[1] U.S., Department of Commerce, Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol. II (Washington, D.C.: GPO, 1970), Table 4, "General Statistics, by Employment Size of Establishment: 1967" (SIC 3241).

[2] "Review and Forecast: Cement", Pit and Quarry, January 1971, p.77.

The newer plants can absorb more transport cost and have larger market areas to serve because they have lower barrel costs that continue to fall as the operating rate moves toward capacity. Therefore, the new and efficient plants are probably operating near capacity in order to capture part of the market of older, less efficient plants.

The older plants finally reach a stage at which the capital brings no return, and are abandoned or modernized. Between 1967 and 1970, 16 plants were closed while 11 plants were opened and 15 plants were modernized. In 1970, the net capacity dropped 2 million barrels from the all-time high of 518 million barrels.[1]

Since sales of Portland cement are tied closely to construction activity, projections would likewise be based on this kind of activity. Construction is expected to increase, though probably erratically, and this will provide new markets for cement. The variability in demand (as opposed to elasticity) is at all times a problem, but it will not be affected by pollution abatement expenditure.

Pollution Abatement Costs

It should first be reiterated that this analysis is concerned only with air pollution abatement costs and does not include all costs of environmental protection.

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[1] "Review and Forecast: Cement", Pit and Quarry, January 1971, p.80. In 1970, eleven plants were shut down while two new plants were opened and three new kilns were installed in older plants. Most of the 1971 planned expansion activity involves installation of pollution control equipment, pp. 82-86.

The three major sources of particulate emissions in a Portland cement plant are: raw material dryer (for the dry process), rotary kiln and clinker cooler. The wet process requires an electrostatic precipitator for the kiln, while the dry process requires glass fabric filters.

It is estimated that 13 percent of all cement plants will require completely new systems while 63 percent are already partially controlled and 24 percent fully controlled.[1] Approximately $50 million have already been invested by the newer plants; the annualized costs are $10 million.[2] In addition, $8 million are currently spent on operating and maintenance costs (i.e., for air pollution abatement).

An additional investment of $103 million will be required for air pollution abatement by the partially or uncontrolled plants.[3] This amounts to $20.6 million in annualized costs and an additional $16.7 million per year in operating and maintenance costs. The total additional annualized cost of pollution abatement is thus $37.3 million.

If all costs are taken into consideration, the annualized costs of pollution abatement are about 4.4 percent figure of value of shipments for the industry as a whole ($1,247 million). Of this, about

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[1] Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D.C.: GPO, 1971), Table 4-4, p. 4-34.

[2] If an amortization period of 10 years, and interest rate of 14 percent are assumed, annualized costs are one fifth the initial cost. Ibid.

[3] Ibid., pp.4-17.

1.4 percent has already been incurred and an industry adjustment made. The 4.4 percent can be divided into two parts: 2.5 percent represents average annualized investment costs of pollution abatement, and the remaining 1.9 percent operating and maintenance costs.

No information is presently available to indicate that the cost of pollution abatement is high as a proportion of value of shipments for obsolescent plants.

Economic Analysis

1.0 Incidence of Average Pollution Abatement Costs

The demand for cement is relatively price inelastic; that is, the quantity demanded will not vary very much in response to changes in price.[1] Cement is used both in ready-mix concrete and in various forms of construction. For most uses, there are few important substitutes or complements. The price of cement tends to be a small portion of the total cost of construction. Demand is particularly price inelastic in the short run since builders are usually locked into specific designs requiring specific amounts of concrete. Prices will therefore increase rapidly to cover the costs of most plants.

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[1] The quantity demanded varies considerably in response to changes in construction activity, but once decisions are made to begin construction, cement is used more or less regardless of price. A change in the price of cement will not have much effect on decisions to commence construction.

1.1 Long-Run Incidence

In the long run, supply is assumed to be price elastic; in other words, unit costs are expected to be constant. In this special case, the price, irrespective of quantity demanded, must rise by essentially the full increase in the exogenous pollution abatement costs. Since the average annualized pollution abatement cost is estimated to amount to 4.4 percent of value of shipments (see Pollution Abatement Costs, above), the price is estimated to rise by roughly this amount in the long run.[1]

The quantity demanded is determined (in the case of price elastic supply) by the price elasticity of demand for the product. Since demand is assumed to be relatively price inelastic, it follows that the reduction in value of shipments would be small, even in the absence of year-to-year growth in sales. Over the last decade, real output has increased. In the long run, then, quantity demanded will continue to increase though at a slightly slower rate than if pollution abatement were not required.

1.2 Short-Run Incidence

It is important to consider the effects on the industry of the transition period when the price is being increased to cover the average pollution abatement cost. The relevant questions are (1) how long will it take to increase prices by the full cost of pollution abatement, and (2) which establishments will be unable to absorb the costs during this interim period?

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[1] Because considerable investment in pollution abatement has already been undertaken, part of this price increase has already taken place. This consideration will be discussed below. See 2.0 Differential Costs.

Since the industry is assumed to be capital intensive, it follows that supply is price inelastic in the short run. Demand, is also price inelastic since it is difficult for builders to change their requirements on short notice. The price will, therefore, increase rapidly as capacity is used up, but few newcomers will be tempted to build plants until a profit margin is reestablished. In periods of excess capacity, however, prices will tend to fall as before. Thus Portland cement plants will not be likely to pass on any cost until demand increases sufficiently to remove much of the excess capacity now existing. Since demand for cement is increasing, the price increase should be accommodated within relatively few years.[1]

Since the process is capital intensive, plants are unlikely to lay-off many workers unless the decision is taken to cease operations entirely. As long as it is possible to assume that the plants are a homogenous group, this eventuality is not likely to occur. Exceptions will be discussed in 2.0 Differential Cost, below.

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[1] Again, it must be noted that part of the changes have already taken place, since some plants are already controlled. See 2.0 Differential Cost, below.

2.0 Differential Cost

Although most plants in the industry will have little trouble in passing on their average costs of pollution abatement, individual plants with high costs will be in a more difficult situation, in that their customers may have access to cheaper alternative sources of supply, namely those plants with lower abatement costs. The differential will therefore have to be absorbed by the equity holders,[1] who must decide whether to go out of business or to accept the increased cost burden.

If a plant does go out of business, there may be additional transition costs which the community as a whole must bear, principally the cost of prolonged unemployment for the workers concerned.

2.1 Causes of Differential Cost[2]

There are three major reasons for differential cost: size of the plant, process employed and legislative requirements. In the case of capital intensive industries, the processes employed are of importance; i.e., some plants are obsolescent and require three times as many employees as new plants for the same output.[3]

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[1] Those plants whose costs are lower than the average may, of course, profit by the pollution abatement regulations. See Chapter 3.

[2] For a fuller discussion, see Chapters 3 and Appendix B.

[3] The difference in pollution abatement costs for wet and dry process plants is of less significance in this situation because it appears to be quite minor (perhaps 1 percent of value of shipments per year).

These obsolescent plants are still in existence because the industry is capital intensive, and the techniques used are not so obsolete as to bring the return to capital down to zero. With an industry-wide payroll at 30 percent of value added, however, these plants must have a very low return on capital. Statistics are not available, but it seems reasonable to assume that the oldest plants have a payroll of 80 to 90 percent of value added. Consequently price swings that are not of major importance to the industry as a whole may well bite deeply into the obsolescent plant's return to capital. The result is that these plants tend to vary their levels of operation much more than the new plants and in course of time come to produce only spasmodically. Employment tends to vary considerably in response to changing demand.

2.2 Cost Differentials for Cement Plants

There are no figures available to indicate that the cost of pollution abatement in relation to capacity is greater for old plants than for new ones. Nevertheless, excess capacity exists in the industry, and it is likely that old plants, as peak producers, operate at a much lower percent of capacity than do new plants. Moreover, many new and modernized plants have already installed pollution abatement equipment. It is assumed here that these considerations will result in a differential cost of about 3 percent[1] of value of shipments if obsolescent plants are now forced to abate, in addition to the assumed cost of 3 percent to be faced by the bulk of the industry for a period of years (see 1.2 Short Run Incidence, above). This assumption is arbitrary, and is made only to permit the formal analysis below.

These older plants will therefore face an initial loss of 6 percent which is reduced to 3 percent in the long run. For purposes of discussing whether they will decide to accept this cost, or go out of business, they are classified as "long-run" and "short-run" viable before investment in pollution control.

2.2.1 Long-Run. It was noted above (Industry Economics) that obsolescent plants require as much as three times the labor per barrel of output as new plants. From this fact, it was assumed (2.1 Causes of Differential Cost) that only 10 to 20 percent of value added reflects gross return to capital. This in turn means that the gross return to capital is only about 10 to 15 percent of value of shipments.

Financial statistics on salvage values are not available on a 4-digit SIC industry basis. Nevertheless, some estimate can be made: the building and land, for example, can probably be converted to other uses. Beyond that, however, the salvage value of the operation (plant, equipment, goodwill) would appear to be negligible. Each of the obsolescent plants, at a very generous estimate, would lose a net return of only 5 to 10 percent of value of shipments by ceasing operations.[1]

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[1] Internal Revenue Service (IRS) data for the comparable 2-digit SIC industry (Stone, Clay and Glass Products) indicate that the sum of rent, interest and taxes in 1967 amounted to $678 million, or about 4.9 percent of business receipts of $13,742 million. U.S. Department of the Treasury, Internal Revenue Service, Statistics of Income, 1967: Business Income Tax Returns (Washington, D.C.: GPO, August 1970), p.9.

This figure (4.9 percent) probably understates the return which could be made in an alternative use, particularly for the 13 obsolescent plants with which this study is concerned.

Since this range would be only slightly greater than the 6 percent (declining to 3 percent) of value of shipments assumed to be incurred through pollution abatement, the incentive for these 13 plants to continue operations would be limited. It is likely that several plants would be modernized or replaced regardless of pollution abatement regulations. A few, however, may close without replacement. The total number of employees involved is about 4,000 to 5,000; perhaps 3,000 could be expected to lose their jobs since modernization reduces the requirement for labor. The cost of subsidizing their continued employment by paying the cost of pollution abatement, might run to several hundred thousand dollars annually.

If this analysis were repeated for the partially modernized plants, it would be seen that conditions are less extreme, and all of these could be expected to absorb differential costs that might arise.

2.2.2 Short-Run. A different analysis must be employed for plants that will cease operation in the near future even without incurring pollution abatement costs. In such situations, the costs cannot be looked at in terms of annual costs since these plants will not remain in operation for the 10-year estimated life of the equipment upon which these costs are calculated.

It was assumed that annualized costs to the obsolescent plants would be about 6 percent of value of shipments. In line with Pollution Abatement Costs, above, it is assumed that 2 percent represents operating and maintenance costs, while 4 percent represents annualized investment costs. This latter figure is equivalent to an initial investment of 20 percent of one year's value of shipments.[1] It may be that none of this capital cost can be recovered for two or three years (until excess capacity in the industry vanishes). Thus operating and maintenance costs of 2 percent per year would also have to be borne initially until the industry raised its price. Table 1 illustrates a possible situation. Plants with an expected life of fewer than five years would not have an incentive to continue operations. Because this period of time is so long, it becomes clear why even long-run viable but obsolescent plants (i.e., before abatement) would have little incentive to continue: they might have to operate five years or more without any return on investment at all.

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[1] The investment cost was obtained originally as a dollar cost. This was annualized by dividing by 5 (interest rate of 14 percent, and amortized over 10 years).

Table Cement-1

SHORT-RUN VIABILITY[1]

Years of Operation	Costs Incurred[2]	Accumulated Costs[3]	Benefits[4]	Accumulated Benefits[3]	Net Incentive[2]
1	22	22.00	8	8	-14.00
2	2	23.75	8	15.02	-8.73
3	2	25.29	8	21.18	-4.11
4	2	26.64	11	28.60	1.96

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1. All figures are expressed as a percent of one year's value of shipments.

2. Initial investment cost is assumed to be 20 percent of one year's value of shipments. Each year's operating and maintenance charges total 2 percent of the year's value of shipments.

3. Present value, assuming a discount rate of 14 percent.

4. Benefits include 8 percent of value of shipments (i.e., the return above opportunity costs) each year and a price increase of 3 percent after a period of three years.

2.3 Summary

Assuming costs of pollution abatement fall within the range of figures discussed in this section, it is likely that the 13 firms not presently abating will cease operations if compliance with pollution abatement regulations becomes necessary. While most, if not all, will be modernized or replaced, the loss in jobs might be as much as 3,000 employees. This would occur at some future date in any event, and would require large subsidies if unemployment were forestalled.

Most of the remaining plants have already at least partially modernized and, therefore, have greater expectations for the future. These plants will not alter their employment or output in response to pollution abatement requirements.

3.0 Sensitivity Analysis

As a rough judge of the acceptability of these estimates, a sensitivity analysis can be performed by varying each number in turn to determine its effect on the overall conclusions.

3.1 Stability of Price Considerations

There is little reason to doubt the accuracy of the estimated average annualized pollution abatement cost of 4.4 percent of value of shipments. (See Pollution Abatement Costs, above.) For the purposes of a sensitivity analysis, however, an extreme case is here postulated and the assumption made that annualized pollution abatement costs for cement are tripled to 13.2 percent of value of shipments.

analysis, however, an extreme case is here postulated and the assumption made that annualized pollution abatement costs for cement costs are tripled to 13.2 percent of value of shipments.

In the long run, the price will rise by essentially the full annualized cost of pollution abatement -- in this estimate, 13.2 percent. In the short run, however, supply is price inelastic, and the price may not rise fully for several years. The inelasticity of demand suggests that this time frame will be limited once present excess capacity is eliminated.

Since gross return to capital averages about 45 percent of shipments for the industry as a whole, it is not likely that even a 10 to 15 percent cost in terms of value of shipments would result in failures of "average" firms. This is particularly the case since the losses would occur for a few years only.

It is clear, however, that the obsolescent plants considered would close immediately. Those still requiring extensive modifications would also have little incentive to continue.

3.2 Differential Pollution Abatement Costs

The closure rate is usually more sensitive to the differential than the average cost (expressed as a percentage of value of shipments). This is less true for capital intensive than labor intensive industries because the former may experience greater difficulty in raising prices when they have excess capacity.

It is sufficient to consider only the most obsolescent group of plants, i.e., those with the greatest cost of labor and supplies per unit of output. Other groups of plants are likely to absorb differential costs because they cannot afford to cease operations. In the example considered above, all of the obsolescent plants would close even with relatively minor differential costs (see 2.0 Differential Costs.)

3.3 The Effect of Misinformation

As outlined in Chapter 4, it is possible that financial institutions will not recognize that pollution abatement requirements in an industry will be followed by price increases. In effect, it might be assumed that the entire cost of pollution abatement will be borne by the firms themselves.

This problem is not of great significance in a capital intensive industry if excess capacity exists. The reason is that prices will not increase for some years in any event, and the discounted value of future price increases, which financial institutions might ignore, is low. In a period of increasing prices (i.e., when there is no excess capacity), it seems likely that the plant could persuade the bank that price increases could be expected to continue. Even in this situation, few potentially viable firms would be turned down.

3.4 Uncertainty

The above discussion has concerned the number of firms which would close rather than pay specific levels of pollution abatement costs. A banker, however, must determine which firms close. As pointed out in Chapter 4, this is particularly difficult when either price elasticity or cross-elasticity of demand is high. Neither appears to be the case for the hydraulic cement industry. The possibility of fluctuating prices due to supply price elasticity in the the short run may create some uncertainty, but the arguments of 3.3 The Effect of Misinformation can be expected to hold.

3.5 Summary

For the Portland cement industry, few figures appear to require more than rough estimation. It is, however, of crucial importance to separate out the most obsolete plants from the rest and to determine with a fair degree of accuracy, the relative costs of labor and supplies per unit of output. Any impact on employment will come from the failure or replacement of these plants.

CASE STUDY #3: PRIMARY COPPER SMELTERS

Objective

This section is a methodological exercise to illustrate the application of predictive criteria to a resource intensive industry. The data used are again, in many cases, outdated or incomplete; therefore the quantitative results are for illustrative purposes only.

Context

The primary copper industry has been selected as an example of a resource intensive industry because the cost of materials, mainly copper. at $935 million, is 79 percent of value of shipments at $1,184 million.[1] The industry is clearly concerned with processing raw materials. The smelting process itself is relatively capital intensive since payroll (80.6 million) is only 30.7 percent of value added ($262.6 million),[2] considerably below the 47 percent figure for all manufacturing. Consequently, the short run repercussions in the industry are similar to those for capital intensive industries.

Industry Economics

Of copper produced a large proportion is used for electrical transmission and equipment, substantial amounts in automobiles and plumbing. Substitution of aluminum is possible in the first two instances, depending on price, and is increasing in automobile manufacture. For some types of plumbing, plastics are substitutes. World capacity has been increasing faster than world demand, while military requirements for copper are declining. There may therefore be excess capacity by the mid-1970's, with consequent price decreases in contrast to the rising prices of the 1960's.[1] This situation, of course, is not related to environmental costs.

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[1] U.S. Department of Commerce, Bureau of the Census, 1967 U.S. Census of Manufacturing: Industry Statistics, Vol. II (Washington, D.C.: GPO, 1970), Table 4, "General Statistics, by Employment Size of Establishment: 1967" (SIC 3331).

[2] Ibid.

Since copper ore is reduced in volume considerably in the refining process, there is a tendency for smelters to locate close to major ore deposits. However, the price of copper is high compared to its transportation costs, and the local markets tend, therefore, to cover large areas. International trade is important as about 15 percent of copper ore is imported, while almost as much is exported after refining.[2] This consideration limits the ability of producers to pass costs on to their customers or back to the mine-owners, since competitors in other countries, except possibly Canada, do not necessarily face similar environmental costs.[3]

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[1] Average weighted prices of domestic copper deliveries increased from about $.31/lb. in 1963 to $.48/lb. in 1969; for foreign copper, the increase was greater: from $.31/lb. to $.63/lb. U.S., Department of the Interior, Bureau of Mines, Bureau of Mines Minerals Yearbook (1967 and 1969) (Washington, D.C.: GPO, 1967, 1969). Copper -- tables 29 (1967) and 32 (1969).

[2] In 1969, U.S. exports of copper aggregated to $315 million while imports amounted to $414 million. Ibid.

[3] Exports from the U.S. are principally to Canada and Mexico, while imports are principally from Peru, Chile and Canada. When only imports of refined copper are considered, in 1969 Canada exported 60 percent of the total, and Chile 15 percent. Ibid.

A good 85 percent of copper mined in the U.S. comes from open pits, and this mining, by contrast with smelting, is a labor intensive industry. As outlined in Case Study #1 above, a labor intensive industry is more likely to reduce output and employment than to reduce prices significantly. This situation limits the ability of smelters to recover part of the costs of pollution abatement by paying less for ore. Over the long run, price differentials according to the sulfur content of the ore may induce extraction of ores with low abatement costs.

Pollution Abatement Costs

It should first be reiterated that this analysis is concerned only with air pollution abatement costs and does not include all costs of environmental protection. The major air pollution problem for copper smelters comes from sulfur oxide emissions; the extent of the problem and the cost of controlling it depend both upon techniques used in the smelting process and upon the percentage of sulfur in the copper ore.

The relevant techniques are roasting (a preliminary process used by five very old plants as well as some of the most recent), conversion and reverberation. For the roasting process, which gives off gases rich in sulfur compounds, the appropriate abatement technique in most cases is to install a sulfuric acid recovery plant. Indeed four such plants are already in operation at a profit.[1] For converters, whose emissions are generally less rich in sulfur compounds, the choice is between an acid recovery plant or a lime scrubber; if the price for sulfuric acid falls substantially many plants may decide to use the latter. At the reverberator stage, emissions contain so little sulfur that lime scrubbers are the obvious solution.

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[1] Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D.C.: GPO, 1971), p. 4-112.

The total investment cost of abatement estimated at $87 million with an annual cost by fiscal year 1976 of $42 million.[1] (These costs are maximal since they do not reflect any recovery from the sale of sulfuric acid.[2]) The annualized cost for the typical establishment would be 5.3 percent of the value of shipments.[3] Of this about 1.6 percent represents the annualized investment cost, and the remaining 3.7 percent represents annual operating and maintenance costs.

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1. Report of the Administrator of the Environmental Protection Agency, The Economics of Clean Air (Washington, D.C.: GPO, 1971), p. 4-103.

2. If only lime scrubbers are used to remove the sulfur the total investment cost would be $63.6 million with an annual cost by fiscal 1976 of $29.6 million. (This figure is obtained by comparing average firm costs for sulfuric recovery plants and the average costs when lime scrubbers are used exclusively.) In this case, there is no recovery of saleable products. The average annualized cost for an establishment would be 3.7 percent of the value of shipments. (This figure is obtained by dividing the annual costs of $29.6 million by the value of shipments of $800 million.) Ibid., p. 4-112, 4-113.

3. Ibid., p. 4-20.

Economic Analysis

1.0 Price Changes

Since the primary copper industry is resource intensive, it is assumed that supply increases only in response to price increases in the long run (see Chapter 2). For the short run, it is necessary to look at the particular characteristics of the industry. Since the actual smelting process is capital intensive, industry supply is relatively price inelastic in the short run; that is, the quantity sold will tend to vary little with price fluctuations.[1]

The demand for copper appears to be relatively price inelastic. That is, the quantity demanded will not vary markedly in response to changes in price.[2] This conclusion is reinforced by realization that aluminum, the major compecitor in copper markets, will be faced with somewhat higher costs for air pollution abatement than will copper.[3] Nor is copper often a major cost component of the service desired or of the customer's budget. Discretionary purchases of copper are limited. In the short run then, demand for copper is relatively price inelastic, while in the long run, this is less so.

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[1] But note that the conclusion is limited to some extent by the more labor intensive influence of the mines themselves.

[2] It seems more likely that changes in autonomous demand have greater influence on price fluctuations than the moderating influence of changing the quantity supplied.

[3] Aluminum cost of abatement is estimated at 6.9 percent of value of shipments in comparison with copper's 5.3 percent. Ibid., p 4-20.

1.1 Long-Run Incidence

In the long run, supply increases only as price increases. Thus, with an addition of air pollution abatement costs, estimated here at 5.3 percent of value of shipments, the price will tend to increase by less than this amount.

The quantity demanded is determined by the intersection of the demand and supply curves. The position of the new intersection depends on the relative elasticities of the two curves. The fact that demand is relatively price inelastic (especially considering that substitutes will bear similar cost burdens), and that supply of ore does not appear to be on the extreme of inelasticity, suggest that retrenchment will be minor. A considerable portion of this burden will be carried by customers, but part may be carried by both mine owners and owners of the smelters. The cost to the latter will come about primarily in the form of market encroachments by international competition which does not have the same environmental costs.

It seems likely that the distribution of costs in the long run may be as much as a 3 percent price increase, 1.5 percent reduction in prices of the ore and perhaps 1 percent loss to the smelter owners in an attempt to meet competition. The figures should, however, be treated with considerable caution. If this were the case, some reduction in employment in domestic ore production might be expected, but the extent would be very small. No employment effect would be noted at the smelters since the 1 percent figure is small compared to the 15.4 percent of value of shipments representing gross return to capital.[1]

1.2 Short-Run Incidence

It is important to consider the effects on the industry of the transition period during which the price is being increased to aid in covering the average pollution abatement cost. The relevant questions are (1) how long will it take for price increases to take effect, and (2) which establishments will be unable to absorb the costs during this interim period.

Supply is relatively price inelastic in the short run. Demand, however, is also price inelastic, since it is difficult for buyers to find cheaper substitutes, especially on short notice. The price will therefore increase rapidly as capacity is used up, yet few newcomers will be tempted to build plants.

In periods of excess capacity, however, prices will tend to fall as before. This is a particular problem for the primary copper industry since demand is expected to recede substantially from the peaks achieved in the late 1960's. Thus price increases to cover the costs of pollution abatement may not occur until the late 1970's unless substantial numbers of plants are closed down in the interim.

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1. Value added less payroll was $182 million in 1967. This is 15.4 percent of the year's value of shipments of $1104 million. U. S., Department of Commerce, Bureau of the Census, 1967 U. S. Census of Manufacturing: Industry Statistics, Vol. II (Washington, D. C.: Government Printing Office, 1970), Table 4, "General Statistics, by Employment Size of Establishment: 1967" (SIC 3331).

The most likely result would appear to be closure of a small number of obsolescent plants, (see 2.2.2 Short-Run Plants, below) accompanied by a reduction in production by the rest. This in turn would result in lower prices for the ore, along with decreased employment and production.

2.0 Differential Cost

Most smelters within the industry will be able to absorb or pass on their costs of pollution abatement (assuming the figures used are appropriate estimates), individual plants with high costs will be in a more difficult situation, in that their customers will probably have access to cheaper alternative sources of supply, namely those plants with lower abatement costs. The differential will therefore have to be absorbed by the equity holders, who must decide whether to go out of business or to accept the increased cost burden.

If a plant does go out of business, there may be additional transitional costs which the community as a whole must bear, principally the cost of prolonged unemployment for the workers concerned.

2.1 Causes of Differential Cost[1]

There are three major reasons for differential cost: plant size, process employed, and legislative requirements. The most important source of difference is different processes employed, as several "generations" of copper smelters exist.

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[1] For a fuller discussion, see Chapter 3 and Appendix B.

The oldest type utilizes roasters before the ore is passed through the converters and reverberators. These obsolescent plants are still in existence because the production method is capital intensive, and the techniques used are not so obsolete as to bring the return to capital down to zero. Statistics are not available, but if the average gross return on capital is 15.4 percent of value of shipments, the obsolescent plants may obtain a return much lower than this. Although in this case the oldest plants are unlikely to have greater costs of pollution abatement in terms of sales than the average, they may have difficulty in absorbing costs for several years.

2.2 Cost Differentials for Smelters

There are no figures available to indicate that the cost of pollution abatement in relation to capacity is greater for obsolescent plants than for modern ones. Nevertheless, excess capacity will exist in the industry by the mid-1970's, and it is likely that the older plants will tend to be used only for peak production, and therefore operate at a much lower percent of capacity than do new plants. On the other hand, since the oldest plants use roasters, they have the best opportunity to reduce abatement costs through the recovery of sulfuric acid.

Obsolescent plants will therefore be assumed to face the industry average costs: 5.3 percent of value of shipments for several years, dropping to 1 percent. For purposes of discussing whether these plants decide to accept this cost, or go out of business, they are classified as "long-run" or "short-run" viable before investment in pollution abatement.

2.2.1 Long-Run Plants. In some cases obsolescent plants can coexist for many years with newer versions. In this case the impending excess capacity may well result in a number of failures among the most obsolescent plants: this contingency is outside the terms of this, which considers only the effect of pollution abatement costs, other things being equal.

While it is established that plants within the primary copper industry vary in productivity, information is not available concerning the relationship of payroll to value added. Nor can a precise measure of opportunity costs be calculated since financial statistics are not presently available on a 4-digit SIC basis. Nevertheless, some estimate can be made based on IRS data for the comparable 2-digit SIC industry.[1] In order to overstate the magnitude of unemployment it is assumed here that a plant could cease operations, and the cash obtained as the salvage value of the plant could be reinvested to return an amount equal to 10 percent of value of shipments.

It seems likely that even the obsolescent plants can earn more than this sum through producing copper: moreover the mines they purchase from have probably been worked for some period of years, with few alternative opportunities for sales. If the cost of pollution abatement cannot be borne by the producers themselves, the mines will in all probability be forced to renegotiate their contracts.

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[1] IRS data for the comparable 2-digit SIC industry (Primary Metal Industries) indicate that the sum of rent, interest, and taxes in 1967 amounted to $1,768 million, or about 4.4 percent of business receipts of $40,154 million. U. S., Department of the Treasury, Internal Revenue Service, Statistics of Income, 1967: Business Income Tax Returns (Washington, D. C.: GPO, August, 1970), p. 9

This figure (4.4 percent) probably understates the return which could be made in an alternative use because property, at least, is often mortgaged for considerably less than its market value. This would be particularly true of the obsolete, failing establishments with which this study is concerned. To be on the conservative side, then, the figure has been increased to about 10 percent.

2.2.2 Short-Run Plants. A different analysis must be employed for plants which are likely to cease operation in the near future even without incurring pollution abatement costs. In such situations the costs cannot be looked at in terms of annualized costs, since these plants will not remain in operation for the 10-year estimated life of the equipment upon which these costs are calculated.

It was assumed that annualized costs for the obsolescent plants would be 5.3 percent of value of shipments. In line with Pollution Abatement Costs, above, it is assumed here that 3.7 percent represents operating and maintenance costs, while 1.6 percent represents annualized investment costs. This latter figure is equivalent to an initial investment of 8 percent of one year's value of shipments.[1]

Since most of the costs of pollution abatement are associated with operating and maintenance, it is clear that even short-run viable firms would probably be able to pay for pollution abatement. It might be decided, however, that replacement of a plant would be preferable to installing the equipment: this decision, regardless of the public relations surrounding it, would have little to do with pollution abatement.

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[1] The investment cost was obtained originally as a dollar cost. This was annualized by dividing by 5 (interest rate of 14 percent, and amortized over 10 years).

3.0 Sensitivity Analysis

As a rough judge of the acceptability of various estimates, a sensitivity analysis can be performed by varying each figure in turn to determine the effect on the overall conclusions.

3.1 Average Pollution Abatement Costs

The costs used in this section may underestimate total costs. One source indicates much higher costs:

> A study made of the copper industry by an independent engineering firm estimated that the capital investment required to implement controls at 12 western smelters that would allow compliance with Federal ambient air quality standards would be approximately $600 million. This includes the capital cost of new plants necessary to maintain industrywide levels of production, assuming some operations are curtailed to meet the most stringent and universal emission standards.[1]

Of the $600 million, about half the capital cost will be for new smelters.[2] This cost is clearly irrelevant to the overall conclusions of the present study, since the new smelters will not be built unless they are profitable. Nevertheless, since this study is dealing in maximal costs, it is assumed here that this is the appropriate figure to indicate initial investment, with annualized

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1. U. S., Department of the Interior, Bureau of Mines, Control of Sulfur Oxide Emissions in Copper, Lead, and Zinc Smelting (Washington, D. C.: GPO, 1971), p. 3.

2. Ibid., p. 50.

costs of $200 million. Annualized cost of pollution abatement therefore is assumed to represent 10.5 percent of the industry value of shipments.[1]

In the long run, prices will increase by less than the full 10.5 percent. As indicated in 1.1 Long-Run Incidence, p. 6, demand is relatively price inelastic, so that a considerable proportion of this burden will be carried by customers. However some price resistance may cause the mine owners to lose sales, and therefore absorb some of the cost, and the smelters may lose some business to foreign producers.[2]

It is possible, however, that the necessity of absorbing up to 10.5 percent of value of shipments for a period of several years would force some of the obsolete producers into bankruptcy. This would be avoided if the mine owners had limited alternative markets.

3.2 Differential Pollution Abatement Costs

There is no information to indicate that differential pollution abatement costs exist. For a resource intensive industry in which such costs occur, the appropriate sections in the other two case studies in this chapter provide models.

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[1] For the entire industry, value of shipments was $1,895 million. U. S., Department of the Interior, Bureau of Mines, Control of Sulfur Oxide Emissions in Copper, Lead, and Zinc Smelting (Washington, D. C.: GPO, 1971), Table 1, "Primary Nonferrous Smelter Operations," p. 5.

[2] Evidently these last possibilities are considered to be minor by the industry, which expects to retain its position by building new smelters if necessary.

3.3 The Effect of Misinformation

As outlined in Chapter 4, it is possible that financial institutions will not recognize that pollution abatement requirements in an industry will be followed by price increases. In effect, it might be assumed that the entire costs of pollution abatement will have to be borne by the plants themselves.

This problem is not of great significance in a resource intensive industry if excess capacity exists, since prices would not increase for some years in any event. On the other hand, in a period of increasing prices (i.e., when there is no excess capacity), it seems likely that the plant could persuade a bank that price increases could be expected to continue. In this situation, few potentially viable plants would be turned down. In addition, most resource intensive plants are closely associated with their suppliers or customers and can raise funds internally.

3.4 Uncertainty

The above discussion has concerned the number of establishments which would fail rather than pay specific levels of pollution abatement costs. A banker, however, must determine which establishments are likely to fail. As pointed out in Chapter 4, this is particularly difficult when either elasticity or cross-elasticity of demand is high. Neither appears to be the case for the primary copper industry. The possibility of fluctuating prices due to supply price elasticity in the short run may create some uncertainty, but the arguments of The Effect of Misinformation can be expected to hold.

3.5 Summary

For the primary copper industry, it is evident that pollution abatement regulations will not result in significant changes in output of employment. The figures used above are only rough estimates, but it has been indicated that the conclusions remain the same even when these estimates are doubled or tripled. It does not appear likely that there will be any closures as a result of pollution abatement though management may close down obsolescent plants, using the environment as a scapegoat.

CHAPTER 6

PROGRAMS: LEGAL REQUIREMENTS AND POLICY ALTERNATIVES

Summary

In the overwhelming majority of regulatory situations, policy decisions are made for political reasons and not on the basis of Constitutional requirements. Neither the Federal Government nor any state government has a legal obligation to provide assistance to plants or individuals adversely affected by the costs of pollution abatement controls.

However, assuming that a decision is made to provide assistance in order to prevent unemployment, several alternative policies might be adopted according to the circumstances of the case.

The most effective courses of action with regard to economically non-viable plants would be to provide either:

1. No direct assistance to the plant, while instituting training and relocation programs for the benefit of displaced workers, or

2. Subsidies to cover the costs of abatement in whole or in part, or

3. Variances (temporary or permanent) which amount to an indirect form of subsidy.

In the case of potentially viable plants, only two forms of assistance would seem to be appropriate:

1. Loans (direct or guaranteed). The Small Business Administration has both the facilities and experience to handle loans in this connection, and it would seem unnecessary for the Environmental Protection Agency to set up a separate program for the purpose.

2. Variances. If the variance is granted on a temporary basis, charges might be made for the privilege of continuing to pollute. This money could be placed in an escrow fund until a sum large enough to convince financial institutions of the advisability of providing a loan, and to constitute the necessary downpayment for such a loan, has accumulated.

A brief outline is provided of a number of existing federal programs that might be regarded as precedents for adopting one or other of the courses of action listed above.

Government Regulation -- Legal Implications

Before discussing in greater detail the different assistance strategies that the government might pursue, it is important to understand the implications of governmental regulation. In particular, it is important to find out if the government has any obligation to provide compensation or assistance to plants or others affected by the cost of pollution abatement.

Generally, when the Federal Government or a state enacts legislation that is essentially regulatory in nature, no provision needs to be made to compensate the entity being regulated for the cost of complying with the regulation or standards. There appears to be no legal requirement to pay this cost even if a firm finds it impossible to meet the standards and is forced out of business.

Any government is considered to have as an element in its sovereignty the authority, commonly referred to as police power, to make and establish laws for the welfare of its citizens. As long as legislation is designed to protect the health, safety, welfare, or morals of the community, the courts seem willing to permit its enforcement as a proper exercise of police power.

However, the exercise of police powers by the government is limited by the requirements of the Fourteenth Amendment to the United States Constitution which requires the government to pay for private property taken for public use.[1] The courts have interpreted "taking of property" very strictly so that, unless land is actually expropriated by the government,[1] no compensation is paid. The fact that a person's business is so strictly regulated that his income is decreased[2] or that he is prohibited from using his property for its most economically beneficial purpose[3] does not constitute a taking. The states may also use their zoning laws in the same way to prohibit certain uses of the property.[4] Exercise of controls such as these are considered to be a part of the state's legitimate police powers as long as there is a valid reason for the regulation. However, a state cannot prohibit the sole economic use of a person's property, since this would be regarded as a virtual taking of the property. The burden of proving the invalidity of a regulation rests on the person claiming that it is invalid.

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[1] Although the Fourteenth Amendment does not state this in so many words, the courts have given this interpretation to the "due process" clause of the amendment.

The Federal Government is also restricted in its expropriation of private property by the Fifth Amendment to the United States Constitution. The pertinent part of the amendment states that no person shall "be deprived of life, liberty, or property, without due process of law, nor shall private property be taken for public use, without just compensation" (emphasis added). The courts have interpreted this in much the same way as the Fourteenth Amendment prohibition which applies to both the states and the Federal Government. There must be an actual expropriation of property, and not merely a regulation for its use, for compensation to be required.

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[1] This is usually done through the exercise of the power of eminent domain, the right of the government to take possession of property for the public good by compensating the owner for its value. Eminent domain is usually exercised through a compulsory sale to the government of a person's property after a lengthy procedural process.

[2] Williamson v. Lee Optical, 348 U.S. 483 (1955).

[3] Goldblatt v. Hempstead, 369 U.S. 590 (1962) and Blancett v. Montgomery, 398 S. W. 2d. 878 (Ky., 1966).

[4] An authority in land development law has stated that under zoning laws a state could probably eliminate billboards from interstate or state roads without the necessity to pay the billboard owners. George Lefcoe, Land Development Law (Cincinnati: Bobbs-Merrill, Inc., 1966), p. 1403.

Because any laws passed by Congress must be specifically grounded upon some grant of power given to it in the United States Constitution, the police powers of the Federal Government are not so extensive as those of the state governments. However, the grants of authority given to Congress have been very broadly construed by the Supreme Court. For example, the Commerce Clause, which gives Congress the right to regulate interstate commerce,[1] is so broadly interpreted that the regulatory power it conveys to Congress is almost limitless. Under this provision, Congress has passed such diverse legislation as health and safety acts, minimum wage acts, and far-reaching labor legislation. So long as legislation such as this only reduces the value of private property and does not actually expropriate it, then compensation is not required.[2]

Even in cases where the courts have ruled that there has been a taking of property, they have never required the state or Federal Government to pay certain costs, such as relocation costs or loss of good will that are incident to the expropriation. Relocation costs have been held by the courts as analagous to costs that result from the termination of a lease. Since the occupant, if he were a lessor, would have to relocate when his lease expired, the courts say that he is put in no worse position if his property is taken by eminent domain. His right to use the property has ended, and there is accordingly no obligation to pay relocation or other costs involved in re-establishing a business. The courts also refuse to grant compensation for business losses or losses in goodwill because these are considered too speculative to be adequately determined. The theory is that the government is obligated to pay the owner the value of the property, but not the special value that the property may have for its present owner, which would include such elements as relocation costs and goodwill.

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[1] The Commerce Clause is found in the United States Constitution, Article I, Section 8, Clause 3.

[2] Bowles v. Willingham, 321 U.S. 503 (1943).

It is important to note that the decision to grant compensation in the overwhelming majority of regulatory situations is made on the basis of political rather than legal considerations. The government is rarely required to pay for the consequences. In pollution control, this is particularly true since no governmental invasion of property can be shown. In fact, if any property invasion results, it is a result of the polluter's conduct. If viewed in this light, pollution control laws can be viewed as laws to restrict the invasion of property by polluters, instead of an invasion of a polluter's property rights. Any aid, whether in the form of subsidy or other assistance to a firm, would be given strictly for political and policy reasons rather than any Constitutional compensation requirements.

Program Alternatives

Any new government regulation, such as an emission or effluent standard, results in a sudden change of costs to the regulated party. If this change is an increase, the increased costs may be paid by the regulated party (and ultimately these costs are usually passed along to the consumer) or by the government. The proportion in which these costs are borne is essentially a public interest question which is usually decided politically.

In this study it has been assumed that the brunt of the costs will be borne by the private sector or the taxpayer, although those damaged by pollution may still be forced to bear some costs, if standards are not enforced or effective.

While publicity and political interest have generally focused on the need to force the private sector (industry) to clean up pollution, in practice the public sector has borne a large part of the costs through rapid amortization of equipment costs, tax credits, and grants to municipalities for sewage treatment plants. Consequently, the public and private sectors have thus far shared the abatement costs nearly equally.

In spite of this division, it is estimated that in 1970-75 the private sector will have to spend 35.6 billion dollars for air and water pollution abatement equipment.

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1. The Council on Environmental Quality, Second Annual Report, Environmental Quality (Washington, D.C.: GPO, August 1971) p.110

2. Ibid.

There are four basic ways in which the government can respond to the needs of firms adversely affected by the costs of pollution abatement.

1. No Assistance. While no direct assistance would be provided for the plant, frictional problems such as unemployment might be alleviated.

2. Subsidies. Subsidies might be provided to defray a portion of, or even the entire, capital costs of abatement equipment.

3. Loans. Loans to cover the costs could be guaranteed by, or received directly from, the government.

4. Variances. Finally, the government might grant a variance or exemption from enforcement of pollution control laws. Variances can be either short- or long-term; they might even be permanent although this is unlikely because it would result in the pollution continuing indefinitely.

These strategies are not, of course, mutually exclusive; a program of government assistance could contain elements of two or more.

Selectivity

Within each strategy, there are many forms that a particular program might take. For example, subsidies might be given to all firms that incur pollution abatement costs, or only to firms whose costs rise above some determined level. Similarly, a strategy might be focused upon providing assistance uniformly to all areas and individuals. Because of the innumerable ways that a program could be selectively applied, no attempt is made to discuss each strategy in terms of selective application.

Non-Viable Plants

The closure of a plant may create serious difficulties in areas of the country already suffering from high unemployment. There are various courses of action that might be adopted to minimise such problems, in the case of non-viable plants. The effectiveness of each course will depend upon the length of time the plant can be kept in operation, compared with the cost of implementation.

No Assistance

Economically, this strategy has the advantages of forcing all plants to recognize pollution abatement as one of their costs of doing business. It would mean that plants and their consumers would pay the full pollution control costs while those employees who were laid off would bear the full adjustment costs of moving to other jobs. The government has used a similar "no assistance" strategy in its minimum wage acts, although it should be noted that in these cases one reason given for withholding assistance was that firms complying with the law did not incur capital costs, whereas capital costs are the most significant part of abatement costs. In any event, the magnitude of the frictional problems resulting from plant closures will be the most important factor in determining whether or not some assistance should be provided. If there are few closures, or if workers can readily be transferred to other jobs, there will probably be no need to assist either workers or plants.

Frictional Problem Assistance. When a plant closes as a result of government policy, there are precedents for assisting workers and the community affected by the closure. The Trade Adjustment Assistance Program and the Community Economic Adjustment Program provide two examples.

The Trade Adjustment Assistance Program was established under the Trade Expansion Act of 1962. The program was set up to help those industries, firms and workers who would be injured as a result of concessions made in a trade agreement which allowed competitive products to be imported in large quantities. It includes provisions for direct loans, job training, readjustment and relocation allowances. It should be noted, however, that training and relocation programs have not, in the past, proved very successful.

The Community Economic Adjustment Program was established about ten years ago by a directive from the Secretary of Defense, and provides assistance to communities which suffered severe economic effects from personnel cuts, base closings, the termination of major contracts, or other major Defense Department actions.

Subsidies

A direct subsidy may cover all the initial cost of control or some part of it. Most federal programs utilizing this strategy make no attempt to distinguish between plants that do not need the subsidy from those who could not provide the funds themselves, although this distinction could be made. Similarly, most government subsidy programs make no attempt to distinguish between non-viable and potentially viable plants.

A full cost subsidy program would be simple to administer but expensive. The major advantage would be the elimination of adjustment costs in terms of unemployment. Plants would have no new costs associated with the controls, and therefore no costs to pass on to consumers.

The major difficulty with full cost subsidies is that the taxpayer bears the costs of abatement rather than the consumer (or supplier or equity holder). Consequently, pollution control costs are not recognized in product prices and the result is an inefficient allocation of resources. Misallocation could be reduced by applying full cost subsidies selectively.

Alternatively, a subsidy could defray only those abatement costs which the plant could not bear. Cost sharing subsidies of this type would vary according to the needs of particular plants.

Just as full cost subsidies could be selectively applied to increase economic efficiency or to assist only plants with substantial pollution control costs, so also could cost sharing subsidies. For example, cost sharing might be applied only to plants with substantially higher abatement costs than other plants in the industry, provided that the plant is located in a depressed area. This would protect employment in areas where unemployment is a significant problem.

Basically, a cost sharing program helps plants that are most adversely affected by abatement costs. This results in a leveling effect; plants adversely affected by abatement costs receive a subsidy, while those less severely affected do not. Consequently, the actual cost to plants in an industry tends to be the same. This equalization of costs also tends to keep the competitive position of all firms within an industry the same as it was before pollution abatement.

The Maritime Administration has two cost sharing subsidy programs: the Construction-Differential Subsidy and the Operating-Differential Subsidy, which were authorized under the Merchant Marine Act of 1936. Neither of these programs allows the Maritime Administration to increase their aid or give technical assistance in case of threatened bankruptcy in order to protect the government investment. This situation points out the need to provide flexibility in legislation so that program administrators can make programs work as intended.

Variances

Basically, a variance is a statement by a pollution control agency that it will not enforce a pollution control standard against a particular polluter. By the terms of the variance, the polluter is permitted to operate in violation of the applicable standard.

This right to violate the standard is rarely indefinite in duration, although in some cases it might be. Generally, the variance requires compliance within a specified length of time, which means that sooner or later the firm must finance pollution abatement costs. Unless the firm's economic position is drastically changed, it is unlikely that it will be able to pay costs more readily in the future than it can at the present time. Therefore, either the variance must be indefinite or some other course of action must be adopted.

The major disadvantage of a variance is that the costs of damages continue to be borne by those being polluted. Furthermore, because the manufacturer is not forced to include the costs of control in his production costs, prices for products produced by polluters are artificially low.

Consequently, variances are granted only when the pollution control agency determines that the public interest in clean air or water is outweighed by these disadvantages. Determinations are usually made to avert closure or serious unemployment. It is possible that a variance might be the most appropriate solution for non-viable plants, particularly for small plants in rural areas where closure might remove the economic basis of a whole community; in such instances a comparatively insignificant amount of pollution might be the lesser of two evils.

Strategies for Potentially Viable Plants

Government Loans

Government loans are the obvious course of action for assisting potentially viable plants that are unable to obtain commercial financing. The government could either make loans directly to these plants or it could guarantee the repayment of commercial loans.

There would be some administrative costs associated with the provision of direct loans, but the principal determinant of the cost to the government would be the level at which interest rates are set. The interest rate determines the plant's ability to pay, and consequently, the loss rate which the government would have to absorb. If the interest rates were set high enough to cover the cost of government borrowing and the loss rate, the cost to the government would be nil. If the government sets a lower rate, then the loan program would have losses which would be borne by the taxpayer.

A guaranteed commercial loan has the advantage of eliminating the major risk to banks, and the cost to the government is slight. However, even when the government is willing to guarantee a loan, under certain circumstances banks may be unwilling to grant one.

The major federal program which utilizes guaranteed loans is operated by the Small Business Administration (SBA) which was created in 1953. The SBA was set up to provide direct and guaranteed loans to small businesses that had difficulty in raising money from private sources.[1] It was formed to ease two problems commonly associated with bank loans: legal lending limitations and length of maturity. Basically, the SBA provides longer term financing at lower rates and for larger amounts than banks are willing to provide.

The Economic Development Administration (EDA), the principal federal agency giving assistance to depressed areas, has two primary low-interest programs to attract new business to these areas. The first is a grant and low-interest loan program to build public facilities such as schools, sewer systems, dams, roads, sewage treatment plants and so forth, which are necessary to attract business to an area. The second program provides loans to firms to build new plants or expand old ones in an EDA qualified area. As in many other federal assistance programs, the firm must first show that the money is not available on reasonable terms from private sources. More importantly, the firm must

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1. See also Chapter 4.

show that it will be able to provide new, permanent jobs and higher incomes for the area. In addition, there must be reasonable assurance that the firm is capable of repaying the loan.

The EDA has placed its emphasis on attracting medium and large firms to depressed areas, rather than helping small or marginal firms come to or stay in such areas. EDA feels that established firms with a past record of success can most effectively bolster the economy of these depressed areas. Because of this, EDA tends to make a few large loans, rather than many smaller loans. In fiscal 1970, EDA made a total of 40 loans to private firms which averaged just over one million dollars per loan.

Under the Trade Adjustment Assistance Program, which has already been referred to in connection with non-viable plants (see p. 6-10), the Department of Commerce can provide either direct or guaranteed loans for periods of up to 25 years. Up to 90 percent of a loan can be guaranteed, provided the firm can show that it is unable to obtain money elsewhere on reasonable terms. An evaluation of the effectiveness of the program would be premature at this stage. Although it had been in operation for nine years as of May 1970, the Department of Commerce had processed only 22 firm applications and 20 industry applications. Of these, two-thirds of the firm applications had been received during the previous year and a half.[1]

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[1] See Summary of Investigations Under Section 301 of the Trade Expansion Act of 1962, U.S. Tariff Commission, Office of the Secretary, June 1970 (Mimeographed).

Variances

If no loan program is appropriate, variances can be used to assist potentially viable as well as non-viable plants. Although a variance permits the plant to continue polluting, there is a way in which it might be used to encourage abatement. Recipients could be charged for the temporary privilege of being permitted to pollute and the money placed in an escrow fund. Such a policy might well persuade financial institutions to provide a loan for pollution abatement equipment: first, by accumulating the necessary down payment, and secondly, by demonstrating the plant's ability to pay out such sums on a long-term basis. In this way, the variance would generate abatement funds rather than merely affording a period of delay.[1]

In the context of this study, viable plants are understood to mean those which either (1) have adequate internal resources to cover the costs of pollution abatement, or (2) can obtain financing from commercial sources. Government assistance[2] would have no effect on output or unemployment and is therefore not to be recommended.

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[1] This system has been utilized by tenants in apartment buildings in several areas of the country. When the owner is responsible for housing code violation, the rent payments are deposited in an escrow fund that can be used only to repair the violations.

[2] Tax provisions are particularly unwise, since the funds will be counterproductive: the viable establishments can obtain rebates, while the remainder will be worse off than before. For a fuller discussion see Institute of Public Administration, Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography (U.S., Department of Commerce, National Technical Information Service, #PB 203111, 1971).

APPENDICES

APPENDIX A

ECONOMICS OF THE INDIVIDUAL PLANT

This appendix illustrates in mathematical terms the general issues at stake in individual plant decisions on abatement, and the potential effects of the decision to abate on future policy and employment.

If a plant is in operation, it generally follows that anticipated net returns exceed salvage value. That is to say that the discounted cash flow[1] (discounted sum of anticipated revenues less out-of-pocket costs) exceeds the scrap value of physical assets and property; i.e., the net present value of the plant is greater than zero. The proposition is expressed in the following mathematical inequality:

$$(1) \quad DCF - S = NPV > 0 \,\Big|_{t = t_1}$$

where DCF = discounted cash flow,

S = salvage value, and

NPV = net present value

The Decision to Abate

Pollution abatement legislation requires a decision to be made by the owners of all plants: either to comply with the regulations or to cease operations. An initial decision if favor of a capital investment in pollution abatement equipment (exclusive of operating and maintenance costs) will only be taken when the expenditure involved is anticipated to be smaller than the amount of the discounted cash flow, less salvage value (i.e., smaller than the net present value of the plants). It is important to note, however, that pollution abatement requirements will result in changes in cash flow and hence, changes in the actual net value for two reasons:

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[1] For a discussion of discounted cash flow units, see Ezra Solomon, "Alternative rate of return concepts and their implications for utility regulations," The Bell Journal of Economics and Management Science, I, (Spring 1970), pp. 65-81.

1. Revenue will increase because price increases are associated with an industry-wide increase in costs.
2. Costs will change because:
   (a) operating and maintenance costs are increased, and
   (b) prices in supply markets may change.

The appropriate inequality thus becomes:

$$(2) \quad DCF + \Delta DCF - S = NPV + \Delta NPV > PA \Big|_{t=0}$$

where ΔDCF = change in discounted cash flow,

$\Delta NPV = \Delta DCF$ = change in net present value, and

PA = investment cost of pollution abatement

If the conditions expressed by this inequality (2) obtain, the plant will abate in order to continue operations. If the inequality does not obtain, the plant will be unable to pay for pollution abatement and becomes non-viable.

Differential Pollution Abatement Costs.

The general proposition expressed here is modified by the frequent variation of pollution abatement costs, particularly the initial capital expenditures required, as a proportion of sales. Inequality (2) might therefore be rewritten as:

$$(3)\quad DCF + \Delta DCF - S = NPV + \Delta NPV > \overline{PA} + PA_i \Big|_{t=0}$$

where $\overline{PA}$ = industry average investment cost of pollution abatement and

PA_i = differential investment cost of pollution abatement for plant i, and

$\sum PA_i = 0$; by definition

In many cases, prices will increase rapidly for the industry as a whole, by a sufficient amount that the abatement costs of most plants are covered. As a rough approximation, it is here assumed that the change in discounted cash flow (ΔDCF) is equal to the industry average investment cost of pollution abatement. In other words, only the differential investment cost of pollution abatement is an issue. Inequality (3) can therefore be reduced to:

$$(4)\quad DCF - S = NPV > PA_i \Big|_{t=0}$$

That is, if the net present value of the plant (before pollution abatement) exceeds the differential cost of pollution abatement, the plant will not cease operations.

Since the sum of differential costs (PA_i) within an industry is zero, for many plants the figure will be negative, and (4) will obviously hold. For others, the differential cost will be small and (4) will hold. Only in a few cases may the differential investment costs of pollution abatement be so great that inequality (4) would be reversed, and the plant would cease operations rather than abate.

In those instances when the price increase will be delayed, inequality (3) cannot be reduced to (4). In addition to the differential costs of abatement, the plant would have to absorb some part of the average cost figure for the industry as a whole. It follows that short-run plants which also have high differential costs of abatement will be the most likely plants to cease operations.

Future Closures

It is important to recall that decisions regarding plant operation are made on a marginal cost rather than a total cost basis. It follows, then, that once the investment in pollution abatement (PA) is made, it will not affect future decisions. In other words, the plant will continue in operation for as long as the revised discounted cash flow exceeds the salvage value:

$$(5) \quad DCF + \Delta DCF - S = NPV + \Delta NPV > 0 \Big|_{t = t_1 > 0}$$

This new situation differs from the pre-abatement situation only in regard to the change in discounted cash flow at a given point in time (i.e., (5) differs from (1) only by the term ΔDCF). It is unlikely that this change would reduce the net present value of the plant since the increase in revenues resulting from higher industry prices will generally exceed the increase in costs occasioned by the operating and maintenance costs of pollution abatement. It is therefore unlikely that a plant's expected life would be reduced (once it abates) by pollution abatement regulation. Indeed, in the majority of cases, the life expectancy of the plant will be increased by the requirement to abate. That is, if at some future date, without considering pollution abatement, the plant would have ceased operations; i.e., when

$$(6)\quad DCF - S = NPV = 0 \,\Big|_{t = t_1}$$

once the requirement was made, the following would hold

$$(7)\quad DCF + \ DCF - S = NPV + \Delta NPV > 0 \,\Big|_{t = t_1}$$

$$\text{as}\quad \Delta DCF = \ NPV > 0 \,\Big|_{t = t_1}$$

Plant Reductions in Employment

There are two instances which might result in a reduction of the plant work force. The first concerns abandonment of a particular operation for which the investment costs of abatement exceed prospective net present value of the operation. It is obvious that once abatement is carried out for a particular operation, its expected life will probably be extended.

Once abatement is carried out, it is also possible that the change in cash flows may induce changes in short-run decisions regarding employment. If this change is negative, i.e., if

$$(8)\quad \Delta DCF \,\Big|_{t = t_1} - \Delta DCF \,\Big|_{t = t_2 > t_1} < 0$$

the appropriate reaction may be to reduce output and possibly employment as well. The importance of this is miniscule since there are several caveats. First, even short-run situations of this kind will be rare because in most cases prices will rise rapidly above the increase in costs. Second, only where labor costs are very high in terms of value added (i.e., well above 50 percent) would any reduction in work force be profitable. Third, the possibility of losing skilled workers should give pause to management thinking of short-run layoffs. Finally, the reduction in cash flow is likely to be so small and of such short duration that management response will probably be nil. Moreover, in the longer run, inequality (8) will be reversed, and mandatory abatement for the industry might well mean a rise rather than a fall in employment for those plants that decide to abate.

APPENDIX B

LEGISLATIVE CONTROL OF POLLUTION ABATEMENT

Effects of Differing Standards

The requirements for the abatement of pollution for a particular plant are determined by local (state or area) implementation plans which, in turn, depend to some extend on the observed deviation from ambient air or water quality standards of the area. In general, the more numerous the sources and the more pollution each emits, the greater will be the burden imposed by the implementation plan. Industrialized areas will tend to have stricter standards, and consequently higher costs of environmental abatement than will non-industrial areas.[1]

There is considerably less deviation in requirements for water than in those for air. Currently, states in their pollution implementation of plans can meet federal standards of ambient air quality in a variety of ways so long as the standards can be reached at all. In contrast, a state's water quality implementation plan must provide that:

1. no stream may have waste disposal as designated use;
2. the present stream quality must not be degraded; and
3. secondary treatment facilities be constructed.

However, in spite of these minimum requirements, there is a great deal of variance between state water programs, and particularily in enforcement procedures, which are almost completely in state hands.[1]

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[1] It should be noted that a considerable portion of the costs result because emission and effluent standards do not take into account the differing marginal costs of abatement by different industries, let alone by different establishments within an industry. For further discussion on this point, see The Institute of Public Administration, Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography (U.S., Department of Commerce, National Technical Information Service, #PB 203111,1971), Chapter 3.

Water Pollution

Under the Federal Water Quality Pollution Control Act, as amended in 1965, the states are required to establish water quality standards in accordance with water uses, which implies that there may be different standards in different parts of the same stream. Since effluent standards are not prescribed on a national basis, implementation plans in general tend to vary according to the availability of water within a community,[2] as well as to the assimilative capacity of streams.[3] One significant departure from the overall trend occurs where municipalities allow industrial

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1. "Federal Guidelines on Water Quality," Environmental Reporter No. 31, (Washington, D.C.: The Bureau of National Affairs, Inc., 1971), pp. 5121-3

2. Where water pollution is concerned, however, a simple urban-rural dichotomy is not a reliable method of estimating differential pollution abatement requirements. Discharges in rural areas into a stream frequently reach a downstream urban area with so little dilution that they still severely affect the water quality. In a situation such as this it may be best to frame an implementation plan in the rural area so that it includes the effect of the discharge on the urban area.

3. The assimilative capacity of streams can differ substantially. For example, the slower moving rivers in the South tend not to acquire as much oxygen from the air as the faster flowing northern rivers,and consequently have less assimilative capacity. This may well be reflected (ceteris paribus) in stricter effluent standards for, say textile plants in the South than are applied in the North.

polluters to use municipal waste treatment plants at costs far below the costs of building their own plants.[1] Because these benefits depend on local considerations, one plant may obtain a competitive advantage over other less fortunate members of the industry.

Air Pollution

Air pollution abatement is handled in a somewhat different manner. The Clean Air Amendments of 1970 require that ambient air standards be set in each air quality region, and the procedure allows little scope for variance since the ambient air standard depends on public health criteria. In this respect, there is even less variation in water pollution, since state implementation plans must not permit degradation and must allow for secondary treatment. Even so, emission standards vary in accordance with differences in state implementation plans, and will generally be less stringent in areas where the air quality is already close to satisfying national ambient air standards.

Movements toward Uniformity of Standards

New stationary sources must satisfy a national emission "standard of performance" which varies according to the pollutant emitted and the size (according to process weight) of the source. The 1970 Amendments require all sources, when expanding or modifying their operations, to meet the standards of performance set on a national basis for new sources. This means that within a few years a very substantial proportion of the nation's industry will be required to meet uniform national standards, rather than the varying standards of individual states and municipalities.[1]

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[1] Often the low cost reflects a sizeable federal grant for waste treatment to the municipality; these may run as high as 55 percent of total capital cost. The municipalities which offer low cost treatment do seem, however, to be violating the spirit, if not the letter, of the Clean Water Act, since the Federal government apparently has little, if any, interest in subsidizing the treatment of industrial waste.

Recent federal legislation indicates that problems resulting from differential regulations and surveillance will be limited in scope. The few areas with notably stiff regulations have tended to be in regions of historically strong economic growth and resiliency (such as Los Angeles) which would be little affected by the closing of a few operations. Most important, the trend of federal legislation toward national standards indicates that legislative requirements will have a decreasing significance in bringing about differential effects.

International Control Requirements

Although the Organization for Economic Cooperation and Development has sought to harmonize national practices in assigning the cost of environmental protection in order to minimize possible adverse trade effects, the U.S. economy is not expected to be significantly affected even if U.S. industry has disproportionally higher costs. Few U.S. exports and imports are commodities bearing high costs for pollution abatement; of the total U.S. imports and exports in 1969, less than 20 percent of each were from industry groups with high costs for pollution abatement.[1] Moreover, other developed nations have similar, sometimes more severe, limitations on pollution.[2]

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[1] Promulgation of national uniform standards for both air and water appears to be the likely result of present and proposed legislation. On one hand, defining the issue at the national level perhaps provides conservation groups with greater and more uniform leverage against industrialists associated with pollution whose opinions might prevail at a lower governmental level. On the other hand, there are definite benefits to a system which differentiates between those regions where substantial abatement is needed and other regions where they are less necessary but where economic growth is more necessary. For further discussion, see The Institute of Public Administration, Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography (U.S., Department of Commerce, National Technical Information Service, #PB 203111,1971), especially Chapter 10, "Questions of Adaptability."

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[1] The Council on Environmental Quality, The Second Annual Report, Environmental Quality (Washington, D.C.: GPO, August 1971), p. 133.

[2]

> The Finnish pulp and paper industry, a powerful competitor and big dollar-earner on world export markets, is coming under increased attack on the question of water pollution.
>
> Finnish industrialists reply by citing impressive cleanup programs, arguing that they are doing more than mills in the United States or Canada . . .

John M. Lee, "Finns Attack Paper Industry on Pollution," The New York Times, May 19, 1971.

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GLOSSARY

capital intensive industry: an industry which uses a relatively large proportion of capital in relation to labor. Taking 47.1 as the average percentage for all manufacturing, as an industry payroll falls below this percentage of value added it is more readily defined as capital intensive. (See Table 2-1.)

demand: the call for a product by consumers within a unit of time, combined with the power to purchase. It is determined by a number of variables including the uses to which a product can be put, consumer tastes and income, size of the consumer market and the price of the product and of competative products.

cash flow: the sum of profits and depreciation allowances. Cash flow represents the total funds that corporations generate internally for investment in the modernization and expansion of plants and equipment and for working capital.

differential pollution abatement costs: the proportion (in relation to sales) by which the investment costs of pollution abatement for an individual plant differ from the industry average. (Note that for some plants this figure is less than zero since the sum of the differential costs for all plants is defined to be zero.

elastic: responsive to price changes. A demand or supply schedule is perfectly elastic if an unlimited amount is demanded or offered at all prices.

establishment: See "plant."

firm: a financial entity which may consist of one or more plants.

inelastic: relatively insensitive to price changes. A demand or supply schedule is perfectly inelastic if the quantity demanded or offered is the same regardless of price.

investment cost of pollution abatement: initial outlay on pollution abatement equipment, design, installation, etc.

labor intensive industry: an industry which uses a relatively large proportion of labor in relation to capital. Taking 47.1 as the average percentage for all manufacturing, as an industry payroll exceeds this percentage of value added it is more readily defined as labor intensive. (See Table 2-1.)

marginal cost: the additional cost that a producer incurs by making one additional unit of output. The concept of marginal cost plays a key role in determining the quantity of goods produced by a plant. Marginal costs are equated to marginal revenue (additional revenue) to obtain the highest profits.

net present value: the sum of a stream of future revenues, less the stream of future costs, when each stream is discounted at an appropriate interest rate.

non-viable plants: those which cannot afford to pay for pollution abatement costs and would therefore require a subsidy if they are to continue in operation.

plant (or establishment): a single physical entity producing goods and services. The plant buys labor and other resource materials, transforms these materials through a productive process, adding value, and sells these goods or services in another market.

potentially viable plant: those which could pay pollution costs *if* they could secure a loan to cover the necessary initial outlay but are unable to borrow the necessary funds from a commercial lending institution.

price elasticity of demand: the percentage change in the quantity of a commodity demanded in response to a percentage change in the price of that commodity, when the price change is small (all other prices assumed unchanged).

price elasticity of supply: the percentage change in the quantity of a commodity supplied in response to a percentage change in the price of that commodity, when the price change is small (all other prices assumed unchanged).

resource intensive industry: an industry which processes a specific raw material.

short-run plants: a plant which is liable to close within a few years even without the imposition of pollution abatement costs.

supply: the amount of a product available for purchase in a given unit of time. For most goods, supply increases with price. The relationship between price and supply is known as the supply curve for the product.

value added: the difference between the value of goods and the cost of materials or supplies that are used in producing them. Value added is derived by subtracting the cost of raw materials, parts, supplies, fuel, goods purchased for resale, electric energy, and contract work from the value of shipments. It is the best money guage of the relative economic importance of a manufacturing industry because it measures that industry's contribution to the economy rather than its gross sales.

variable cost: a cost that depends on changes in output. As production is increased, the variable costs increase; the reverse is also true. Costs of this type include payments for labor, raw materials, and other variable resources. By definition, variable costs are zero when no product is being produced and fixed costs are the only costs that are being incurred.

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INDEX OF SYMBOLS

DCF	Discounted Cash Flow
NPV	Net Present Value
PA	Plant Investment Costs of Pollution Abatement
$\overline{PA}$	Industry Average Investment Costs of Pollution Abatement
PA_i	Differential Investment Cost of Pollution Abatement for Plant i Note that $\sum_i PA_i = 0$
S	Salvage Value
t	Time
t_i	Point i in Time